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NEW ADVERTISEMENTS should be in the office not later than Monday noon to insure publication in that week's issue.

In last week's issue of the ELECTRICAL REVIEW, Dr. Louis Bell discussed the storage battery question as applied to automobiles with his usual lucidity of statement and clearness of expression. The position that he takes is one that is patent to the close observer of the evolution of electric automobiles, but one which seems to have escaped so far the designer of the mechanical part of these vehicles. His plea is for the storage battery to be given a fair chance. Certainly, in the ordinary type of electric vehicles, it has had to struggle with conditions imposed upon it by the design of the vehicle itself—conditions which militated greatly against its proper operation. It is much to be hoped that designers of such vehicles will take counsel of Dr. Bell's sensible observations and endeavor to produce a vehicle that will, at least, give the battery a fair chance to show what it can do.

CENTRAL STATION PRIME MOVERS.

When the incandescent light was introduced for the first time there appeared the necessity for close and accurate regulation of voltage, or what amounted to practically the same thing, for extremely accurate regulation of speed in the driving motor whether this was operated by steam or water power. Engine builders confronted with the demands of the new apparatus rose to the situation and in a short time brought out designs for steam engines in which the regulation was sufficiently close for the purposes of the dynamo. Then began a period in which the peculiar operative conditions surrounding both the electric generator and the steam engine reacted upon each other. The dynamo, as first designed, was essentially a high-speed machine, while the engine of those days was generally a long-stroke slow-speed machine, comparatively inefficient and exceedingly ill regulated. The extreme advantage of directly coupling the one machine to the other was early recognized by Mr. Edison, and he set to work, as he has related formerly in these pages, to solve the really difficult part of the problem—to get a high-speed engine to couple with his dynamo, because he knew that he could easily build a low-speed dynamo to couple with his engine.

It was largely as a result of these experiments that the high-speed engine governed by controlling the cut-off point of its valves was brought out, and also as a consequence of them that multipolar designs of dynamos adapted to run at low speed were contrived and exploited.

With the coming into use of alternating-current generators and the general introduction of the alternating-current system for lighting, it was discovered that, in order to operate such dynamos in parallel with one another, the regulation of speed of the prime mover must not only be of an accurate average, but that the motion itself should be strictly uniform; this is far from the case with the ordinary engine. Indeed, for a long time it looked almost hopeless to attempt to drive alternators in parallel. With the larger machines in use to-day the necessary steadiness of motion, requisite to keep machines running parallel in step and in phase with one another through all parts of their revolutions, has been attained by the use of multi-cylinder engines and the introduction of heavy flywheels as a means of steadying the motion.

In water-power stations there has been an advance so great in the art of governing water-wheels that this particular department of mechanics may be said to date from the time when the necessities for electrical machinery were impressed fully upon makers of hydraulic apparatus. But notwithstanding the excellence that has been attained there are many conditions under which the governing of water-wheels is excessively difficult. The parts to be moved for the control of an ordinary turbine are heavy and cumbrous, and there is always the inertia of a large body of water falling through the wheel to be taken into account, so that even with the best governors employing auxiliary power regulation as good as that of the steam engine is difficult to obtain.

Still, in at least one important essential the turbine-wheel is superior to the steam engine for driving alternating and polyphase apparatus. This is the absolute steadiness of its motion, the impulses driving the wheel being continuous and producing constant rotation with no tendency to accelerate or retard at any portion of a revolution as is the case with the steam engine. For this reason water-power plants in which the regulation is perhaps not the very best have been exceedingly successful and accidents have rarely occurred due to machines getting out of step or becoming heated by the exchange of heavy wattless currents. Such a plant, however, is difficult in the extreme to regulate when it is running on a widely varying load. In normal prac-

tice on loads of small variation, if two or more dynamos are coupled, all of the regulation will be done by the one with the most sensitive governor, the others running along steadily at full load or open gate on the water-wheels. The one machine which combines the close regulation of the steam engine with the rotary motion and entire steadiness of rotation of the water-wheel is the steam turbine. Why this remarkable and highly-efficient engine has not found larger use in American central stations is difficult to understand. It has been proven in practice, in Great Britain, that it is entirely satisfactory for driving electrical apparatus, and that in addition to its excellent features of regulation and steadiness of motion it is highly economical in steam consumption and floor space. For the operation of alternators in parallel it seems to be practically ideal.

It is pleasing to be able to note that within a short time some very large turbine installations will be set to work in the United States, and that we may soon have some experience of our own in regard to this form of prime mover.

THE PAN-AMERICAN EXPOSITION.

The Pan-American Exposition at Buffalo, N. Y., was officially opened Wednesday of this week, although the exercises of its dedication, in which the chief magistrates of all the American nations will participate, will not be held until May 20. Owing to the long season of rain work on the grounds and the installation of exhibits have been somewhat delayed and it will be two or three weeks yet before the exposition is fully completed and at its best.

Meanwhile, the principal feature of its attractions is in operating condition and is alone well worth the journey to Buffalo to see. Never before in the history of the art has decorative electric lighting been carried to such a point, or handled with such artistic felicity. On other pages of this issue will be found the first article of a series describing the electrical features of the exposition in some detail. The decorative lighting is the feature that will attract most attention, both from electrical people and the public at large. Next to the astonishing magnitude and great beauty of the display upon the grounds, perhaps the most interesting fact in connection with it is that the decorative lighting is operated from the twenty-five-cycle Niagara Falls current—a thing that many people supposed impossible. There is absolutely no observable flickering of the lights on this current and their burning is entirely satisfactory to those who installed the decorative illuminations.

Electric fountain effects, first tried on a large scale at the World's Fair, at Chicago, in 1893, and developed somewhat more in detail at Paris last Summer, have found their highest expression at the Pan-American Exposition. Both in magnitude, diversity of effect and in beauty these strange stationary fireworks have surpassed all others that have been attempted. Of all the illuminations in the history of festival occasions, Buffalo, this Summer, shows the greatest. How interesting it would be if, for example, Louis XIV, with the memory of his illuminated gardens at Versailles, could be awakened to see what the Twentieth Century can accomplish in this direction!

To the engineers in charge of the design and construction of the electrical features of the exposition too much credit can not be given. Mr. Luther Stieringer, the consulting engineer for electrical illuminations; Mr. Henry Rustin, chief of the Mechanical and Electrical Bureau, and Mr. George F. Sever, superintendent of the electrical exhibits, have all worked *con amore* to produce the flattering success that has attended their efforts. That they have worked hard as well as intelligently can not be doubted by those who witness the beautiful display at Buffalo.

The National Electric Light Association is particularly happy in the choice of a meeting place for its convention on May 21, 22 and 23. Niagara Falls is a good place at which to hold conventions for two reasons: It is a place that every good American wishes to visit once or oftener during his lifetime, and it is so small that convention delegates are not able to wander away and lose sight of one another, as is sometimes the case when meetings are held in great cities. This Summer the presence of the Pan-American Exposition at Buffalo near-by will add an additional attraction to the meeting.

DEVELOPMENTS IN THE TELEPHONE FIELD.

The election of Mr. Frederick P. Fish president of the parent Bell telephone company, and of Mr. John I. Sabin, of San Francisco, president of the Chicago and Central Union Telephone companies, evidently signifies vigorous expansion of these telephone interests. Mr. Sabin will bring to the task at Chicago, which is the proper headquarters for the Middle and Western States, the prestige of success on the Pacific Coast and marked energy with which to handle the many complex questions that seem inherent to the telephone business, its peculiar franchise rights and its relation to its users, the public. He succeeds two good men—the former presidents of the Chicago Telephone Company and the Central Union Telephone Company.

It is probable that there will be seen in the United States within a short time a further consolidation and concentration of management of the telephone companies licensed by the parent Bell company, and the logic of the situation points to a rearrangement of these companies under one central control with able men at the heads of divisions of territory arranged with more respect to geographical lines than present companies' territories.

The independent telephone companies are stronger than ever before and possess a popular following that gives them a particular strength in the telephone world. Possessing manufacturing facilities, both numerous and efficient, their growth is constant and widespread. The recent clearing up of the patent situation leaves the field a fairly open one between the Bell and the independent interests, and out of the competition is sure to result, to our mind, a great benefit to the public and a noticeable increase in the use of the telephone—a long step toward the universal application of the telephone that is coming with accelerating pace.

SAVING AT THE SPIGOT.

It has been announced that the Buffalo, N. Y., City Council has decided, on account of increase in telephone rates in that city, to cut out all appropriations for city telephones except those for police and fire service. The saving effected in this way will amount to $5,000 a year. What the loss will amount to no man can calculate now, but it is very certain that it will be many times greater than the small saving apparently realized.

It is a curious step backward for an enterprising industrial centre like Buffalo to take. It would have been far less surprising if, even in view of increased service charges, the city had increased its telephone service, thereby securing more than commensurate advantages for the outlay of a comparatively small sum of money. All business men know nowadays that they can not get along without the telephone. Its abolition in such centres of commerce and finance as New York city would produce a stagnation in business that would immediately lead to disaster.

THE BROOKLYN-STATEN ISLAND TUNNEL.

A proposal has recently come before the Railroad Commissioners of the State of New York for the construction of a submarine electric railway tunnel between the boroughs of Brooklyn and Richmond, in New York city. In brief, the proposal is to build the tunnel under the waters of New York Harbor between Brooklyn and Port Richmond, Staten Island, and to connect its Brooklyn end with the Rapid Transit tunnel which is now being excavated in New York, so that the Rapid Transit company's trains may run directly through to Staten Island. For some unknown reason the plan has not been cordially welcomed by the daily press and many in authority. It is, therefore, somewhat doubtful if it can go through, but if, in the course of events, it should happen that our commissioners let an opportunity of this sort pass by unheeded, it would be a grave mistake.

Such a tunnel, and such electric train service as is proposed for transit through it, with high rates of speed between Staten Island and New York, which form an integral part of the plan, would not only be an almost immeasurable convenience, but would bring into the metropolis a volume of merchandise and money which now go elsewhere. Commercially, such a plan is invaluable; socially, it is of equal benefit. Persons who now live within the narrow confines of the busiest city in the world would be enabled to reside on the picturesque little island down the bay, and still be within easy striking distance of their various offices without having recourse to the slow and cumbersome ferries, which, in Winter, are not infrequently seriously delayed by ice floes and heavy weather. To live in the country, out of the noise and dust of the city, is the ideal existence, the one for which man was primarily intended, for the man who works at high pressure requires peace and quiet after the day's work is ended.

It is only beginning to be realized by statisticians and political economists that electricity is a factor of tremendous importance in the development of countries and peoples. The industrial supremacy of Great Britain, maintained during more than a generation, was due to steam—due to the coal fields of England and the inventive and mechanical skill of the people who utilized the gifts of Nature in the development of their industries and became the foremost manufacturing nation. This country is contesting that supremacy because of superior advantages of the same kind, but a factor of no small importance in the contest is the electrical development which has enabled it to conserve its forces and utilize its resources to the best advantage. The electric railway alone has added an almost incalculable sum to this country's values. Electrical development of water power has harnessed the sunshine falling upon vast areas and set it to work in the factory and shop. Electricity has freed innumerable people from manual labor to allow them better opportunities in other directions. This advance has been much more rapid than was the development of steam power that enabled the Yorkshire looms to make cloth for half the world. What its economic results will be can not now be stated, but that they will be of inestimable value to us can not be denied.

NEW CABLE LAYING.

It is stated in press telegrams that Holland and Germany will unite in the construction of a system of cables of the far east rendering them independent to the British lines. It is also said that while the principal terminus of the system will be at Shanghai branches will connect with Japan and possibly with the United States.

This may or may not be true but it is only a symptom of the constant increase in cable laying which is going on about the world. There seems now little doubt that we will soon have a trans-pacific cable completing the electric circuit of the earth. As has been pointed out before in these columns, as soon as that link is constructed it will practically double the capacity of existing systems; for interruptions must occur on both sides of any point to isolate it from others. For example, Shanghai could communicate with New York either *via* the trans-pacific or the coastwise, Indian Ocean, Red Sea, Mediterranean and trans-atlantic routes. It seems, indeed, rather likely that the era of cable building in the Pacific Ocean which is about to commence will result in the construction of several systems instead of one, and the effect of this will naturally be greatly to increase the opportunities of American exporters in the eastern markets, Australia, Japan and China.

It is gratifying to notice an awakening of interest in the library of the American Institute of Electrical Engineers, as evidenced by recent gifts of a substantial character to it. The library is already one in which the Institute may justly take pride, and its situation at a central point in the electrical business district of New York city makes it all the more valuable to members who may wish to use it. Among the recent gifts may be mentioned a large number of bound volumes comprising complete sets of electrical publications, and together numbering no less than three hundred and sixty-five volumes. Among those who thus liberally added to the resources of the library may be mentioned Messrs. Edward Caldwell, Townsend Wolcott, C. O. Mailloux and the electrical journals. Mr. Mailloux made a liberal donation of money for the purchase and binding of a complete set of the proceedings of the French Academy of Sciences. It is hoped that the liberality noted above is an earnest of continued interest on the part of the Institute's members.

Science Brevities

Telephonic Transmission—If human speech is to be transmitted with complete clearness, every constituent vibration must be reduced in intensity in the same proportion, if at all. That the telephone does not do this is due to the fact that the effective resistance increases with the frequency, while the magnetic induction decreases. This has a serious effect upon distinctness, especially as the frequency of the constituent sounds of human speech vary between such wide limits as 16 and 10,000 vibrations per second. Another complication is introduced by the natural period of the telephone disk. According to Herr Max Wien, says an *Electrician* abstract, a Bell telephone reinforces the notes of 1,100, 2,800 and 6,500 vibrations per second, and several higher pitches as well. A Siemens telephone has two successive maxima at 5,000 and 5,400. The most characteristic notes of the human voice lie between 500 and 3,000, and for these notes the telephones of Bell, Apel and Siemens are equally sensitive. For higher notes the sensitiveness often shows remarkable differences. Thus a modern Siemens & Halske telephone will transmit the note 4,000 nearly 100 times as loudly as a Bell telephone. The author used an alternating-current siren for these investigations.

Aluminum as an Electrode—The fact that an aluminum electrode in a voltameter allows a much stronger current to pass when it acts as a cathode than when it acts as an anode, has never yet been satisfactorily explained, says one of Mr. Fournier d'Albe's abstracts. It is not yet certain even whether the layer which produces the higher resistance consists of silica or of aluminum oxide. The recent researches of Signor A. Bartorelli do not decide this question, but they give valuable information concerning the polarization and the internal resistance of the voltameter in terms of the current traversing it. The maximum polarization acquired by the voltameter when the aluminum is the cathode is a good deal smaller than when it is the anode, the figures being 25 volts and about 3.1 volts, respectively. As regards resistance, it was found that for equal values of the difference of potential between the terminals of the voltameters, its resistance is always less with the aluminum as a cathode than in the opposite case. The ratio of the two resistances varies from a very small value at small electro-motive forces to nearly unity at 25 volts. After both the polarization and the resistance have become constant, the current varies in a linear manner with the electro-motive force, and a small increase in the latter brings about a large increase in the current strength.

Self-Induction in Wehnelt's Interrupter—Mr. T. Mizuno has investigated the effect of self-induction in a Wehnelt circuit, and has confirmed Ruhmer's theory as to the part played by self-induction in reestablishing the broken circuit, says the *Electrician*. What plays the most important part after the break of the circuit in consequence of vaporization is the electro-motive force $L\frac{di}{dt}$ of the current at break. When this electro-motive force is sufficiently large to call forth the spark across the vapor, the current is reestablished, because the vapor on the active electrode is thereby cleared off. Since the whole vapor is simultaneously condensed, the value of the current grows again according to Simon's equation, and the process of vaporization repeats itself. On the other hand, when the electro-motive force of self-induction is not sufficient. the spark can not take place, and the current is greatly reduced by the presence of vapor which adheres to the surface or the active electrode. In the hammer interrupter the spark due to the break must be absorbed by a capacity, whereas in Wehnelt's interrupter the insertion of a capacity in parallel stops its action. The author does not say how the spark at break "clears away" the vapor at the active electrode.

Effect of Invisible Rays Upon the Eye—The impression produced by Becquerel, Rœntgen and ultra-violet rays upon the human eye has a certain fascination on account of its possible utilization in the case of blindness, says Mr. Fournier d'Albe, in one of his abstracts. Rays which penetrate opaque bodies may reach an optical nerve cut off from the outer world by turbid humors or integuments. F. Himstedt and W. A. Nagel have made a long series of experiments in this matter, but practically useful results are much interfered with by the rapid "fatigue" of the eye. After a few exchanges the subject is unable to say which of two packets, one filled with sand and the other with a radium preparation, contains the active element, though at first the latter produces a general luminosity in the eye. It appears certain that none of these rays produces fluorescence in the human eye, though they do in the eyes of some animals. Also, that it is the rods and not the cones of the retina that are chiefly affected. Geometrical impressions may be temporarily created in a blind eye by means of Rœntgen rays transmitted through lead plates in which patterns are cut. A radium preparation produces a luminous sensation, which appears to proceed from the side on which the preparation is held. This is a hitherto unexplained effect.

Electrolytic Deposition of Lead from Solutions—In a valuable paper on this subject, Mr. L. Glaser states that homogeneous metallic lead is deposited from slightly acid concentrated solutions of lead nitrate or acetate, containing, for preference, considerable quantities of the corresponding alkali salts, by a current of about 0.004 ampere per square centimetre at the cathode, says the *Electrical Engineer*. It appears that when an anode of lead is used, the electro-motive force is about 0.1 volt. When the conditions are such that lead hydroxide can be formed at the cathode, spongy lead is deposited. Concentrated solutions of lead or alkali salts dissolve considerable quantities of lead hydroxide; when such a solution is electrolyzed, the removal of lead from the layer of solution in contact with the cathode dilutes it. This more dilute solution deposits the lead hydroxide or basic lead salt which it contains on the cathode, and so prevents the regular deposition of the metal giving rise to the spongy deposit. Lead chloride and sulphate give unsatisfactory results, owing largely to the formation of insoluble lead chloride or peroxide at the lead anode. By using very small current densities and electro-motive forces it is, however, possible to obtain coherent deposits. The deposition of lead may be utilized for plating objects with lead or for separating lead and silver, the alloy being used at anode in a solution of nitrate saturated with chloride; the silver remains behind undissolved. Coherent deposits of lead are also obtained, although with more difficulty, from alkaline solutions. The concentration of the lead ions is so small in these solutions that the liquid surrounding the cathode soon becomes so impoverished that the electro-motive force rises, and the next available cathion (an alkali metal) is discharged. This results in the secondary reduction of lead sponge. By keeping the electro-motive force low and replacing the liquid in contact with the cathode by vigorous stirring, however, good deposits may be obtained. The analogy between the deposition of lead and of zinc is pointed out in conclusion.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XXV.

BY W. ELWELL GOLDSBOROUGH.

In the system shown in Fig. 68 the leads connecting the generator with the two circuits in multiple are supposed to be short and of negligible reactance and resistance. There are many systems, however, in which both the reactance and resistance of the mains over which power

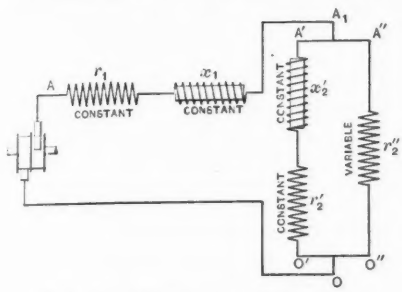

FIG. 71.—ALTERNATING MECHANISMS.

is supplied enter as important factors, and it is, therefore, advisable to extend the discussion of circuits of this class to embrace the more general cases.

Fig. 71 illustrates a system in which the constant inductive reactance of the mains is represented by x_1, and the constant resistance of the mains by r_1. The receiving system OA_1 is composed of two circuits $O'A'$ and $O''A''$ connected in parallel. Of these the circuit $O'A'$ has a constant inductive reactance x_2' and a constant resistance r_2', while the circuit $O''A''$ contains only a non-inductive resistance r_2''. The resistance r_2'' is, however, a variable one, ranging in value from ∞ to *zero;* it is, therefore, a most important factor of the system as a whole, since upon its value, at any given time, depends the relative magnitude of the various forces acting.

In determining what takes place in such a system we can not do better than develop the discussion along the lines of the treatment applied to the arrangement of parts shown in Fig. 68, as the receiving portion OA_1 of Fig. 71 is exactly like Fig. 68. In entering upon the discussion we will assume, for simplicity, that the voltage between the points O and A_1 remains constant, and that as the impedance of the whole system changes the voltage of the alternator E is so modified as to maintain this condition. As far as the receiving system is concerned, then, the conditions will obtain which are shown in the left-hand part of Fig. 72. Here OA_1 is equal to the constant electro-motive force maintained between O and A_1 of Fig. 71. OB^a is the current which this voltage sets up in the circuit $O'A'$ when $r_2'' = \infty$. Then, as already explained in connection with Fig. 69, as r_2'' is gradually reduced, the resultant of the constant current in $O'A'$ and the variable current in $O''A''$, will follow the locus $B^aB^bB^cB^dB^e$, increasing in value and more and more nearly approaching the phase of OA_1 as r_2'' is made less and less.

It is important now to consider what changes must take place in the generator voltage to maintain the constant pressure between O and A_1. Take for instance the initial condition when $r_2' = \infty$. At this time the current, $OB^a = I^a$, flowing through the distributing mains will necessitate the existence of a resistance electro-motive force equal to $I^a r_1$ in the circuit A_1A, and this current will further give rise to a reactive electro-motive force equal to $I^a x_1$. If now from A_1, and parallel to OB^a, we lay off $A_1C_1^a$ equal to $I^a r_1$, and from C_1^a lay off $C_1^aA^a$ at right angles to $A_1C_1^a$ and equal to $I^a x_1$, we can determine the phase position and value of A_1A^a, which is equal to the potential

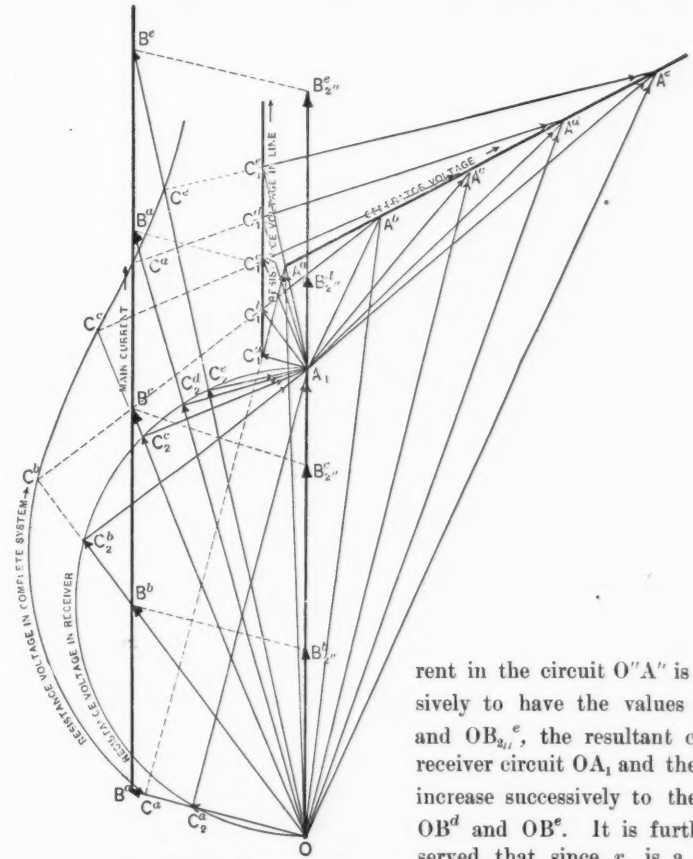

FIG. 72.—ALTERNATING MECHANISMS.

difference E_1 between the points A_1 and A of Fig. 71. To determine the generator electro-motive force it is now only necessary to join O and A^a of Fig. 72, for since $OA_1 = E_2$ and $A_1A^a = E_1$, OA^a must equal E, the resultant of the electro-motive forces appearing at the terminals of the two principal sections of the system. When the value of r_2'' is reduced to the extent of causing a current $OB_{2''}^b$ to flow in the non-inductive circuit $O''A''$, the resultant current in the system will be the resultant of the constant current OB^a, flowing in the circuit $O'A'$, and the current $OB_{2''}^b$.

To determine the voltage required to force the current OB^b through the circuit A_1A we must proceed as previously. Therefore from A_1 lay off the vector $A_1C_1^b = I^b r_1$, where I^b is the current represented by OB^b. Then from C_1^b lay off $C_1^bA^b$ at right angles to $A_1C_1^b$ and equal in length to $I^b x_1$. By joining A_1 and A^b we will have the electro-motive force required to force I^b through the line circuit A_1A. Then the generator electro-motive force required to produce the conditions just outlined will be the resultant of OA_1 and A_1A^b or OA^b. Now when r_2'' is still further reduced and I_2'', the current in the circuit $O''A''$ is made successively to have the values $OB_{2''}^c$, $OB_{2''}^d$ and $OB_{2''}^e$, the resultant current in the receiver circuit OA_1 and the line A_1A will increase successively to the values OB^c, OB^d and OB^e. It is further to be observed that since r_1 is a constant, the resistance electro-motive force of the circuit A_1A changes both in value and phase position proportionally to the current I, therefore the locus of the vector head of the resistance electro-motive force of the circuit A_1A will be the line $C_1^aC_1^e$, which is parallel to B^aB^e. The impedance of the circuit A_1A is a constant and the

electro-motive force at its terminals is always in advance of the current by the amount of a constant angle, therefore, by the geometry of the figure, since E_1 increases proportionally to I, the vector head of the electro-motive force E_1, will progress along the straight line A^aA^e as a locus. And it will attain to the values A_1A^a, A_1A^b, A_1A^c, A_1A^d and A_1A^e as I changes in value from OB^a to OB^e.

And since the variable generator electro-motive force E is the resultant of the variable electro-motive force E_1 and the constant electro-motive force E_2, its vector head will also follow the lines A^aA^e as I varies, and will successively take the values OA^a, OA^b, etc.

It is interesting to note that as r_2'' decreases the lag of the main current I behind the generator electro-motive force E at first diminishes. That is the angle B^aOA^a is greater than the angle B^bOA^b. But after a certain limiting value of r_2'' is reached any further decrease causes the lag angle of I behind E to become greater again. That is the angle B^dOA^d is less than the angle B^eOA^e. Owing to this fact the head of the resistance electro-motive-force vector of the complete system neither follows a circle nor a straight line as I varies, on the contrary, it follows a locus curve $C^aC^bC^cC^dC^e$ which has a point of inflection at the point C^c. The point C^c marks the current value $O B^c$ which is most nearly in phase with the generator electro-motive force E. That is, the angle B^cOA^c is less than either the angle B^bOA^b or the angle B^dOA^d.

The supposition that the generator voltage can be varied at will is a rational one within certain limits. But the conditions imposed by the values assumed in connection with Fig. 72 necessitate an enormous increase in the generator voltage; one beyond the usual bounds of commercial practice. It will, therefore, be profitable to determine what the regulation in the voltage at the receiver terminals O and A_1 would be if a constant voltage was maintained at the generator terminals.

To do this the several voltage vector diagrams of Fig. 72, corresponding to the different values of I, must be separated. The first of these diagrams consists of the vector OA_1 combined with all the vectors the heads of which are designated by the exponent letter *a*. The second of the diagrams consists of the vector OA_1 combined with all the vectors the heads of which are designated by the exponent letter *b*, and so on for the remaining values of I, which are I^c, I^d and I^e. After the diagrams are separated they must be proportionally reduced as follows.

Suppose it is determined to keep the generator voltage constant at a value equal to OA^a. The *a* exponent vector diagram will then not need to be changed. But each vector of the *b* exponent diagram must be reduced in the ratio of the length of OA^a to the length of OA^b. This will make OA^b of the reduced *b* diagram equal in length to OA^a of the *a* diagram. This reduction being completed the *b* diagram must be superimposed upon the *a* diagram in such a way that the reduced value of OA^b coincides with OA^a. The *a* and *b* diagrams will now be in the proper relation to enable a comparison to be made between them, and an initial estimate can then be had of

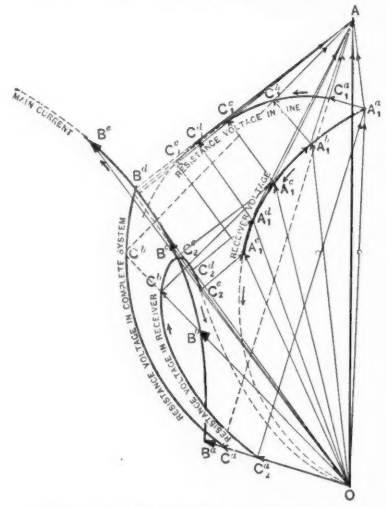

FIG. 73.—ALTERNATING MECHANISMS.

the character of the changes which take place when E is kept constant.

Turning to Fig. 73 the results of reducing and superposing the *b* and *a* diagrams are apparent. The vector OA, Fig. 73, takes the position of both the vectors OA^a and OA^b of Fig. 72. This throws the vector OA_1 of the *a* diagram of Fig. 72 into the position of the vector $OA_1{}^a$ of Fig. 73, and the vector OA_1 of the *b* diagram of Fig. 72 into the position of the vector $OA_1{}^b$ of Fig. 73. The other vector lengths of Fig. 73 that correspond to the *a* and *b* diagrams of Fig. 72 are designated by the same letters in Fig. 73 as they are in Fig. 72, and can, therefore, be readily traced. For instance, the vector OB^a of the *a* diagram of Fig. 72 is the vector OB^a of Fig 73, and the vector OB^b of the *b* diagram of Fig. 72 is the vector from which the vector OB^b of Fig. 73 was reduced.

In transferring the diagram designated by the exponent letter *c* of Fig. 72 to Fig. 73 each of its ordinates was reduced in the ratio of the vector OA^a to the vector OA^c, and in making the transfer of the *d* and *e* exponent diagrams similar reductions were made in the ratio of OA^a to OA^d and OA^e, respectively.

The superposition of the five diagrams *a*, *b*, *c*, *d* and *e*, reduced to the common generator voltage OA, gives the vector diagram of Fig. 73. If now the extremities of all the current vectors are joined by a smooth curve we find that the main current I no longer follows a straight line as a locus when r_2'' is reduced from ∞ to zero; but that it follows the locus $B^aB^bB^cB^dB^e$, Fig. 71, which is a curve bending away from the generator voltage vector. In the same way the locus of the heel of the electro-motive-force triangle is no longer a straight line like $C_1{}^aC_1{}^e$ of Fig. 72. In Fig. 73 it assumes the form of the curve $C_1{}^aC_1{}^cC_1{}^e$. Moreover we find that now the head of the electro-motive-force vector of E_2 follows a locus curve $A_1{}^aA_1{}^cA_1{}^e$ where as previously it was stationary. Under the present conditions, when r_2'' reduces to zero, E_2 will also be zero, and in arriving at this value will follow the dotted extension of its locus curve.

In Fig. 72 the heel of the electro-motive-force triangle of the second, or receiver, circuit followed the semi-circular locus $C_2{}^aC_2{}^cC_2{}^e$, but with a constant generator impressed voltage it follows the loop shown as the curve $C_2{}^aC_2{}^cC_2{}^e$ of Fig. 73. This loop turns upon itself towards the impressed electro-motive-force vector at the time that the current becomes most nearly in phase with the impressed voltage, in fact a line drawn through O and tangent to the loop $C_2{}^aC_2{}^cC_2{}^e$ is also tangent to the current locus $B^aB^cB^e$. These loci illustrate even more forcibly than does the point of inflection C^c, Fig. 72, the fact that there is a certain value of r_2'' for which the angle of lag of the current behind the impressed voltage is a maximum, and that for values of r_2'' on either side of this the current lag increases.

In Fig. 72 it is the head of the resistance or the *effective* electro-motive-force vector that follows the curve which contains the point of inflection C^c. In Fig. 73 this locus curve assumes a very different shape. It is the curve $C^aC^bC^cC^dC^e$ which makes an abrupt return upon itself at the point C^c, for since OA is constant and the angle between the effective and reactive electro-motive forces a right angle, the locus curve must necessarily be part of the periphery of a circle described on OA as diameter. At this point it is interesting to notice that, as a matter of fact, the loci $A_1{}^aA_1{}^cA^e$, $C_1{}^aC_1{}^cC_1{}^e$ and $B^aB^cB^e$, although previously straight lines, are all arcs of circles in Fig. 73.

Fig. 73 is a diagram which presents to the eye a cycle of events dependent upon the variations in the value of r_2'' which can only be expressed mathematically by means of a complicated formula. Fig. 73 brings out in a very pertinent way, therefore, the value of graphical methods when applied to the solution of alternating-current problems.

Operating Conditions of the Nernst Lamp.

M. E. Hospitalier, in a recent issue of *L'Industrie Electrique*, gives an interesting account of experiments made upon a Nernst lamp to determine the conditions of its operation and output. Following is a translation, in abstract, of the article:

The lamp was rated at 220 volts and 80 watts and the experiments made included measurements of its light intensity in various directions under different pressures from 180 to 220 volts. The lamp was mounted on an Edison base and enclosed in a spherical globe of clear glass, which was open to the air. It was furnished with a starting coil and an automatic switch in its base. The globe was a little less than three inches in diameter and the incandescent filament 30 millimetres (one and one-quarter inches) long.

Experiments made at 220 volts give the results shown in Figs. 1, 2 and 3, which represent, respectively, the luminous intensity measured, as follows:

1. In a horizontal plane passing through the filament.

2. In a vertical plane perpendicular to the axis of the filament and passing through its middle.

3. In a vertical plane passing through the filament.

The lamp was set up vertically, the base being the lowest part. The following table gives the results found for an energy consumption of 90 watts:

LUMINOUS INTENSITY IN CANDLE-POWER.

	Maximum.	Mean.
In the horizontal plane	44	30
In the vertical plane perpendicular to the filament	82	37
In the vertical plane passing through the filament	82	25
Mean spherical candle-power, 50		

The curves of Fig. 4 exhibit fluctuations of light intensity due to varying the potential differences applied to the lamp and showing the rapid variations of all the functions of the lamp's operation with diminishing potential. A variation of five per cent in the applied electro-motive force gives one ot 25 per cent in the luminous intensity.

While the efficiency of the lamp is as good as one watt per candle-power in the direction of maximum intensity, it is 2.9 watts per candle-power for the mean spherical candle-power. Below 180 volts pressure the lamp is rapidly extinguished by the increase which takes place in resistance of its filament.

As far as the quality of its light is concerned the new Nernst lamp gives entire satisfaction. The exaggeration of the luminous intensity in the direction of the axis of the lamp is attributed in part to the reflecting power of the white support upon which the lamp is mounted and also in part to reflections taking place in the interior of the spherical bulb surrounding the lamp. In a horizontal direction there are considerable variations of luminous intensity probably due to refractions in the glass, but which may be partly attributed to shadows cast by the heating spiral.

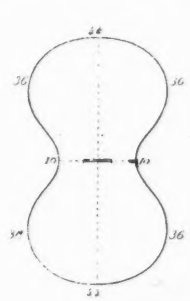

FIG. 1.

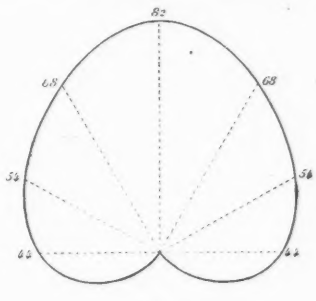

FIG. 2.

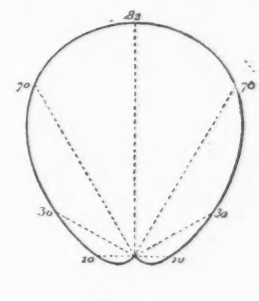

FIG. 3.

LIGHT INTENSITIES OF THE NERNST LAMP MEASURED IN VARIOUS PLANES.

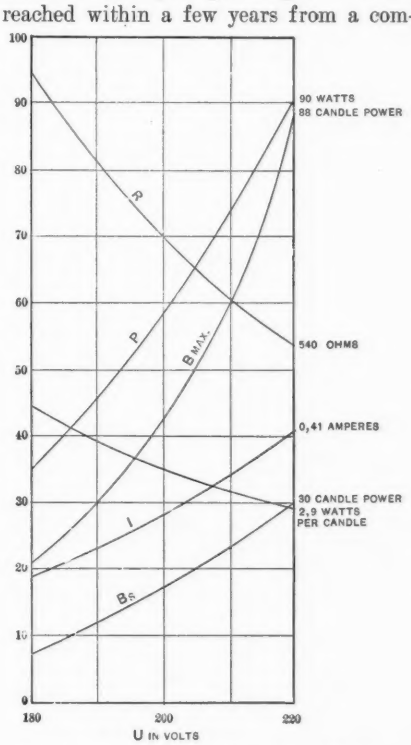

FIG. 4.—WORKING CONDITIONS OF NERNST LAMP BETWEEN 180 AND 220 VOLTS.

The Largest Telephone System.

During the past week the metropolitan system of the New York Telephone Company—which has long been the largest city telephone system in the world—has reached the good round figure of 60,000 stations. This prodigious figure has been reached within a few years from a comparatively small system, as eight years ago, or 15 years after the establishment of the telephone in New York, the number of subscribers was almost stationary at about 10,000. Then began the era of message rates and of an active policy of pushing the business for all it was worth, instead of waiting for patronage to come of its own accord. At the same time the service has been vastly improved, and no effort has been spared to keep the plant always in step with the latest advance in apparatus and operating methods. This is shown very plainly by the fact that during the past three years, while adding new stations at the rate of over 1,000 a month, the entire system has been changed over from magneto to common battery. This has involved new equipment at every exchange and at every subscriber's station. The result of this policy of progress has been that the system has multiplied itself by five in the space of eight years, and this remarkable growth not only shows no signs of falling off but goes on from year to year at an accelerating rate. For example, to take the past four years the growth for the 12 months ending May 1, 1898, was 5,000 stations; for the following year, 8,000 stations; for the next, 12,000 stations, and for the period just closed almost 15,000 stations. The enlightened policy of the New York Telephone Company certainly has its reward, and the New York public bids fair at no distant date to realize the telephonic ideal of a telephone in every place of business and in every residence in the city.

New York Electrical Society.

The two hundred and fourteenth regular meeting of the New York Electrical Society was held on Thursday evening, April 25, at Havemeyer Hall, Columbia University. Mr. Charles F. Scott, chief electrician of the Westinghouse Electric and Manufacturing Company, made the address of the evening, his subject being "Alternating-Current Motors." Lantern slides illustrated the lecture, and motors were shown in operation. Fifteen new members were added to the society's roll.

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Wall Street and the Electrical Stock Market.

On the New York Stock Exchange, General Electric closed the week at 225½ bid and 226 asked, showing a gain of 5½ points. Metropolitan Street Railway, of New York, closed at 172⅞ bid and 173 asked, indicating a loss of 1 point. Brooklyn Rapid Transit closed at 85¼ bid and 85⅜ asked, showing a loss of 1¼ points. Third Avenue Railroad, of New York, closed the week at 125 bid and 126 asked, indicating a loss of 1¼ points. Manhattan Railway, of New York, closed at 128½ bid and 128¾ asked, showing a loss of 1⅜ points for the week.

On the Boston exchange, American Telephone and Telegraph closed the week at 175 bid and 176 asked, showing no change for the week. Erie Telephone closed at 60 bid and 62 asked, indicating a gain of 1 point for the week.

On the Philadelphia exchange, Electric Company of America closed the week at 9 bid and 9¼ asked, showing a loss of ¼ point. Union Traction closed at 31¼ bid and 31½ asked, indicating a loss of ⅛ point.

On the curb, or outside market, in New York, Electric Vehicle closed at 12 bid and 14 asked, showing a loss of ½ point. Electric Boat closed at 18 bid and 21 asked, indicating a loss of 1 point. Consolidated Equipment closed at 7¼ bid and 8 asked, showing no change for the week.

Wall street, April 27.

Meeting of the Municipal Electricians.

A meeting of the Executive Committee of the International Association of Municipal Electricians was held at Niagara Falls on Saturday, April 27. President Morris W. Mead presided. The Mayor of Niagara Falls welcomed the committee, to which response was made by President Mead.

September 2, 3 and 4 was selected as the date for the next convention, and a committee, consisting of Messrs. Mead, Frank C. Mason and J. W. Aydon, was appointed to select topics for the papers to be read on that occasion.

A large number of applications for membership were presented by President Mead and referred to the committee to report on at the next meeting.

General Electric Secures Manhattan Elevated Contract.

On Wednesday of this week it was announced that the General Electric Company had received the contract for electrical equipment of the Manhattan Elevated cars in New York city, amounting to nearly $3,000,000. This practically divides the work of the electrical equipment between the Westinghouse company, which builds the power-house, and the General Electric Company. Each car—800 in all—will have two 100-horse-power motors. The trains will consist of six cars, as a rule.

American Institute of Electrical Engineers.

The 153d meeting of the Institute was held Friday evening, April 26. The papers of the evening were "The Transformer for Measuring Large Direct Currents," by Professor Harris J. Ryan, of Cornell University, and "Electricity in Mountain Mining," by Professor F. W. Brady, of the New Mexico College of Agriculture and Mechanic Arts. The papers were exceedingly interesting and were well received by the members present. The names of 40 new associate members were presented to the Institute for consideration.

Isaiah H. Farnham.

Mr. I. H. Farnham, who was shot and instantly killed by George H. Brainard, at Portland, Me., April 23, was born in

Isaiah H. Farnham.

Woolwich, Me., in 1853. As a youth he was deeply interested in mechanics and electricity and at the time of the introduction of the telephone was in the employ of the Western Union Telegraph Company, to the telephone department of which he was at once transferred. He served as superintendent of the telephone exchange at Portland, Me., and in 1885 he became the electrical engineer of the New England Telephone and Telegraph Company, which position he held at the time of his death. Mr. Farnham was one of the leading figures in the long contention between the telephone and trolley railway companies. He was a successful inventor, holding a large number of patents in the telephone field. A man of studious habits and of extreme modesty, he numbered many friends in the electrical profession. He is survived by a widow and five children.

Brainard, who did the killing, was a capable man and had been in the employ of the New England Telephone and Telegraph Company for a long time. He seems to have become suddenly insane and ran amuck in the telephone exchange building in Portland, shooting right and left. Mr. Farnham was instantly killed; E. M. Buxton, 21 years old, died of his wounds some hours later; James S. Wadsworth, who was very seriously injured, may recover, and Elmer Z. Lane, though severely wounded, will probably recover. Mr. Farnham was buried at Wellesley, Mass., Saturday, April 27.

PERSONAL.

Messrs. A. C. White and W. C. Woodward, of Providence, and E. B. Baker, of New Haven, were electrical visitors to the city of New York last week. All three of the gentlemen were entertained at the annual Horse Show of the Brooklyn Riding and Driving Club by Captain W. L. Candee, of New York.

Mr. Marsden J. Perry, president of the Naragansett Electric Lighting Company, sailed on the Oceanic last week for a vacation of several weeks in Europe. This is the first vacation of any importance that Mr. Perry has taken from very active electrical work in 25 years.

Mr. Charles F. Scott, chief electrician of the Westinghouse Electric and Manufacturing Company, delivered an address before the New York Electrical Society in Havemeyer Hall, Columbia University, New York, on April 25, returning next day to Pittsburgh.

Mr. Charles Cuttriss, chief electrician of the Commercial Cable Company, returned last week from a three weeks' trip abroad in the interest of his company.

The Death of Mr. James D. Reid.

Mr. James D. Reid, one of the oldest telegraph men in the United States, died at his home in New York city, on April 28, at the age of 82 years.

Mr. Reid was born in Edinburgh, Scotland, and when 16 years old went to Canada. A few years later he came to Rochester, N. Y., and there for some years held a position in the city government. During his residence in Rochester he became acquainted with Morse, the inventor of the telegraph, and for awhile was associated with him in perfecting the invention. He went to Pittsburgh for Morse, and there opened the first telegraph office in that part of the country. For a long time afterward he was superintendent of the old Ohio & Pacific Telegraph Company, which was afterward merged with the Western Union company. It was while Mr. Reid was in charge of that district as superintendent that he hired Andrew Carnegie as a messenger boy.

In later years Mr. Carnegie was able to return the favor which had been given him in his early youth by exerting his influence in behalf of Mr. Reid, who was appointed United States Consul at Dunfermline, Scotland, a position he held through two administrations.

In later years Mr. Reid spent much of his time in writing, his book, "The Telegraph in America," having earned a considerable reputation. The convention of telegraphers at Pittsburgh in 1886 gave him a gold medal for his distinguished services in telegraphy and in 1889 the New York Telegraph Club gave him another. He leaves a widow and one daughter.

The New York Electric Vehicle Transportation Company's New Station.

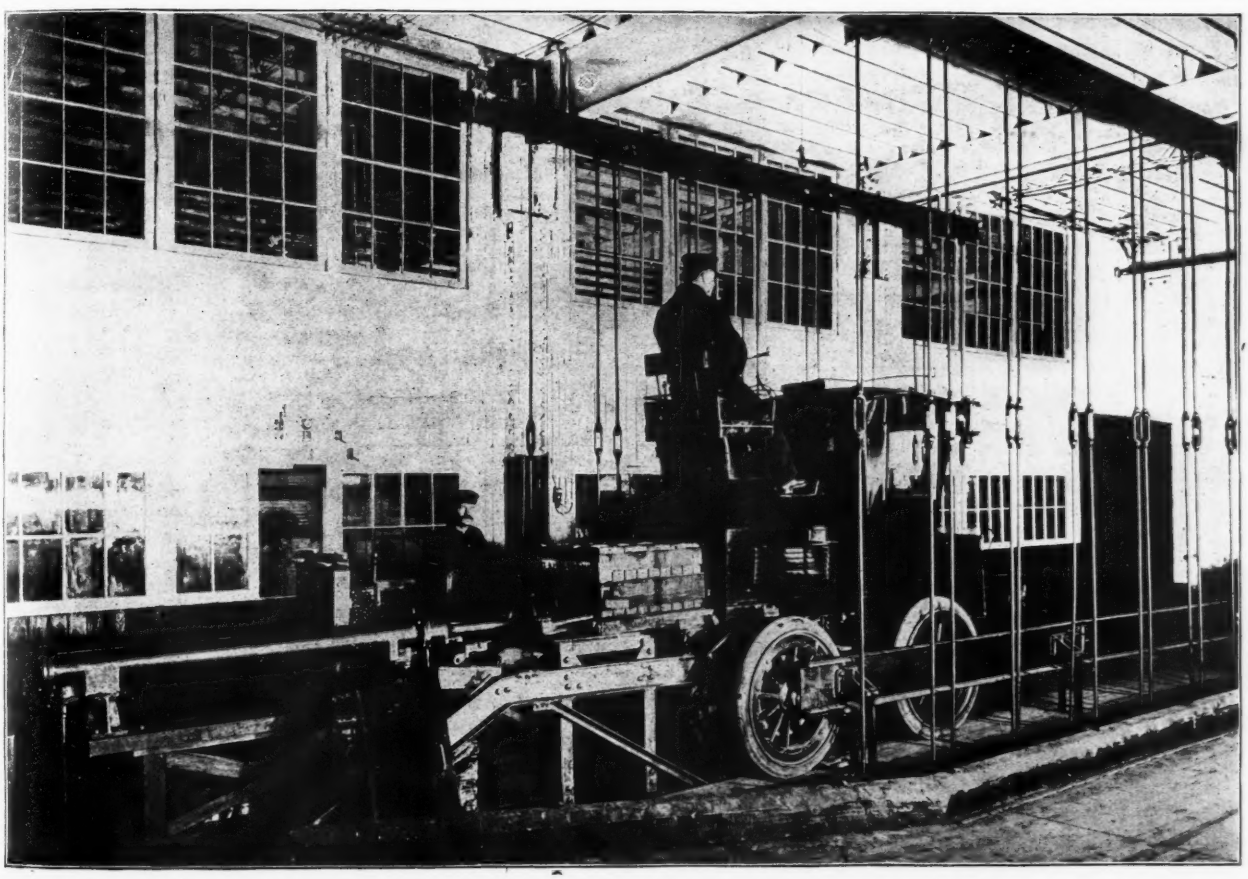
THE PUBLIC electric automobile cab service in New York has grown to considerable proportions. When its beginnings were made four years ago a single room 40 by 100 feet was large enough for the battery-charging room and all the rest of the functions of the company's service. The new station, which has recently been occupied, represents the fourth move of the company into larger quarters, and consists of a three-story brick building situated at Forty-ninth street and Eighth avenue in New York city, fronting half a block on the avenue and extending backward 475 feet. Several hundred vehicles can be accommodated in this building and about 350 are now actually housed in it and used for public and livery service. The first floor of the building is given over to rooms for the assembly, inspection and charging of vehicles in public service, the enormous battery charging room, the substation power plant, and assembly and repair room for batteries, and six loading stands for handling batteries into and out of cabs. At one corner of this floor is situated the boiler room wherein steam is generated for heating the building.

Upon the second floor is situated the main office of the company, storerooms, and a section embracing 27,000 square feet used as a storage loft for vehicles for which there is no immediate use; for example, the closed types of vehicles, such as broughams, are not much called for in warm weather, and these can be conveniently stored in this space at such times. On the northern side of this space, convenient to the battery-charging room below, is located the battery room charging switchboard of which an excellent view is given in one of the illustrations herewith. The third floor is given up entirely to the storage of vehicles, a repair and machine shop, and a large front room which is a lounging room for the use of the employés.

A feature of the company's plant is the care that has been bestowed by it upon the comfort and convenience of its employés. The driver of a cab of whatever kind is naturally exposed to the weather and leads a somewhat irregular existence. The company has provided lockers, bathrooms, lounging, smoking and reading rooms, and all other reasonable conveniences for its men, and in this way has secured the loyal service of an excellent class of operatives.

When vehicles are stored on the second or third floor their batteries are taken out before they are sent upstairs, and hence it is necessary to provide some means of moving them on the upper floors. For this purpose double trolley wires are hung the length of the large rooms, an overrunning trolley working on them and delivering to a cord and plug attached to it a pressure of about 50 volts. When this plug is properly attached to the vehicle the latter may be propelled, though slowly, by working its controller. One of these trolleys is excellently illustrated in one of the illustrations herewith. The cable connected to it is sufficiently long to allow the vehicle to reach any part of the room.

For the present all the electrical energy

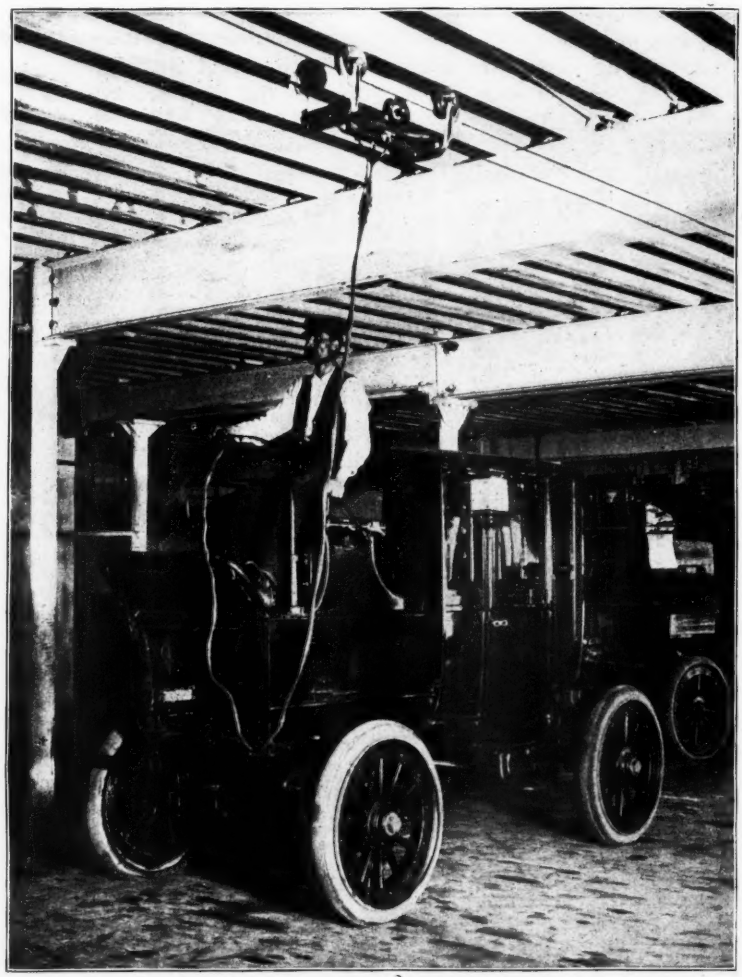


ELECTRIC CAB RECEIVING CHARGED BATTERIES IN THE STATION OF THE NEW YORK ELECTRIC VEHICLE TRANSPORTATION COMPANY.

required to operate the station is received from the Edison Electric Illuminating Company of New York in the shape of 6,300-volt three-phase alternating current, this being the company's standard primary distribution current. On the premises there has been established a substation in which are at present installed four 200-kilowatt General Electric synchronous converters. The high-tension switchboard is placed on the second floor level, and is of the usual type of construction for such boards. Attached to each of its panels is a set of three 145-kilowatt air-cooled transformers mounted on a steel platform supported on the I-beams which hold up the second floor. The platform being hollow it has been found convenient to use it as a cable duct and also as an air duct, the supply of air for cooling the transformers being obtained by a small fan direct coupled to an electric motor. The secondary voltage is about 70 volts, and a regulator of the induction type is connected in between the sets of transformers and the leads to the rotaries. Each set of transformers operates two rotaries, the direct current from the rotaries going to panels on the low-tension board, from whence it is carried to an auxiliary regulating panel operated in connection with the six bus-bars of the battery switchboard on the floor above. This board is so arranged that any of the six bus-bars can be fed directly from the rotary, or through an auxiliary storage battery arranged either to boost or depress the voltage as desired. The present equipment of batteries for this purpose gives six volts either way for altering the rotary voltage. As each of the rotaries can be regulated by means of the voltage regulator connected to its transformers, and as four more variations can be made by the auxiliary batteries, it will be seen that a large number of different bus-bar voltages can be had as desired. At present eight voltages are possible, though six are generally used, and all this is accomplished without the use of a rheostat. In addition to this current supply there is an independent current supply for lighting the building and for operating the cranes, etc., coming from the street circuits of the Edison company. The low-tension switchboard is connected with the battery-charging switchboard by a large number of 1,000,000-circular-mil cables.

The battery-charging switchboard is excellently shown in one of the illustrations. At the back of this board are the six bus-bars mentioned above. Upon each section of it are mounted 10 horizontal charging panels placed one above the other, as the illustration clearly shows, each panel representing a battery-charging stand on the battery-charging floor below. By means of a double-throw switch below each panel the ammeter shown at the top of each row of 10 can be connected in with any one of them. The plug switch arrangement above the double-throw switch is used for connecting the battery to any one of the different bus-bar voltages as desired.

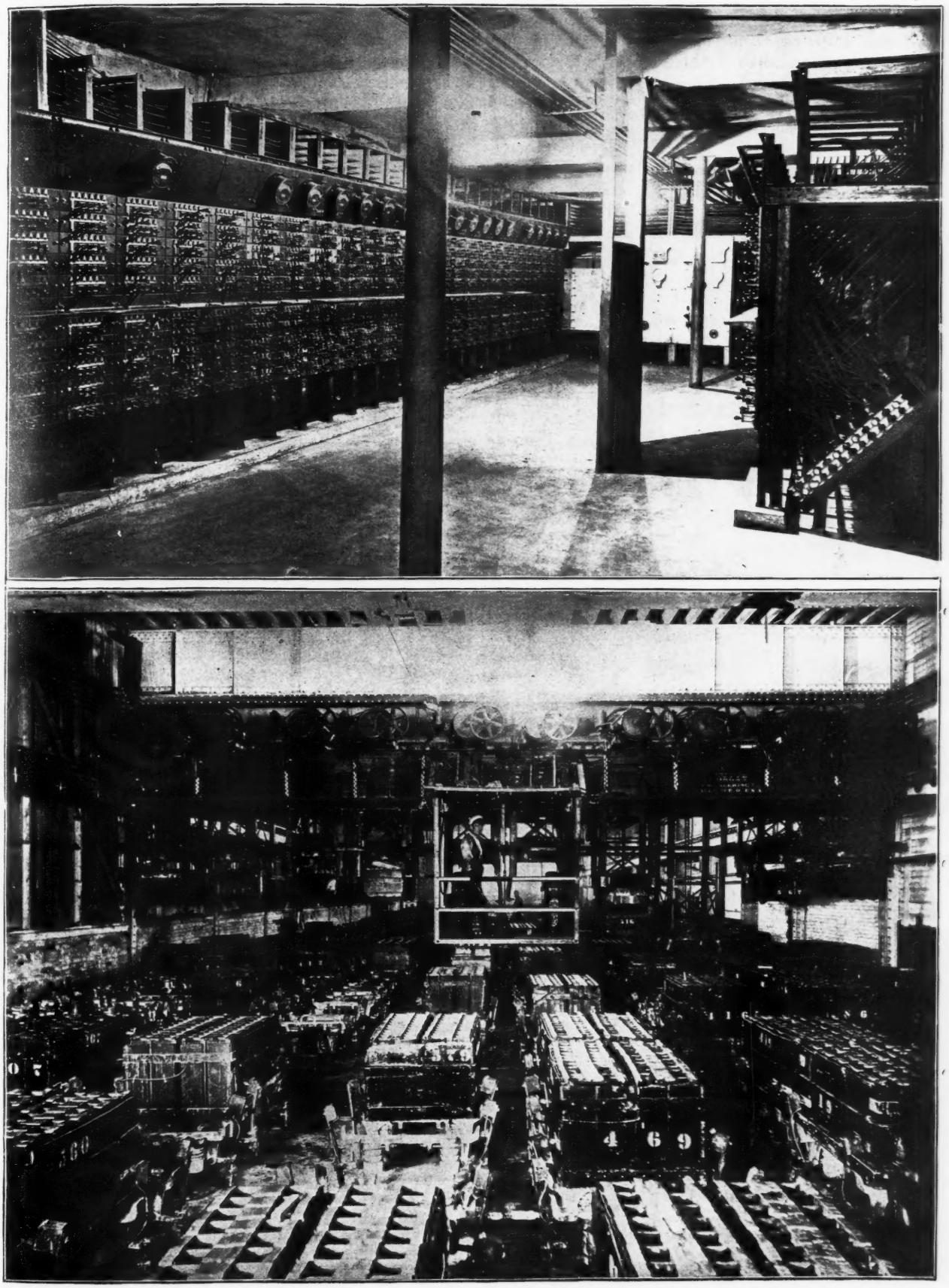
Each of these sections is connected to a charging rack on the main charging floor. This may best be understood by reference to the accompanying illustration. The rack is so constructed that when the battery is lowered on it by the crane shown in the illustration, it is automatically connected in circuit for charging. The switchboard attendant is notified that a rack of such number is occupied. The method of doing this is exceedingly ingenious. Upon each battery rack hangs a small check marked with the number of the rack. When the battery is put on this check is sent by means of a small elevator to the switchboard room and the attendant there receiving it goes to the panel representing that number, plugs in the lowest of the various voltages at his command and turns on the current. A single ammeter reading is sufficient generally to give him an idea of the condition of the battery. If it is proper for it to remain in charge the current consumption is tested occasionally until it falls to a definite limit, when the next higher voltage is plugged in. When the battery is fully charged the switchboard attendant cuts off the current and sends the check back to the charging room, it then being placed on top of the charged battery showing the attendant on the crane that that particular battery is ready for service in an incoming vehicle.



TROLLEY FOR MOVING CABS WITHOUT BATTERIES.

The present installation comprises 640 charging racks, though the capacity of the room and switchboard is for 1,000.

The battery-charging room itself is 300 feet long and over 40 feet wide, floored solidly with concrete and separated from the room in which the vehicles are loaded by a substantial partition. All of the wiring to the charging racks is under the



THE BATTERY-CHARGING APPLIANCES OF THE NEW YORK ELECTRIC VEHICLE TRANSPORTATION COMPANY.

A.—Battery-Charging Switchboard.
B.—Battery-Charging Racks and Cranes.

floor, the channels in which it is run being lined with acid-proof concrete. A careful system of drainage is provided for the battery floor. The room is ventilated by powerful exhaust fans connected with brick flues and capable of renewing the atmosphere of the room once in three minutes.

The battery racks consist of cast-iron pedestals 12 inches high, upon each of which is a heavy porcelain insulator or holder supporting two cast-iron racks. A simple-hinged arm is so arranged that when the weight of the cells is put on the rack the arm swings up to the sides and makes connection with copper strap terminals on the box containing the battery.

Each battery box contains 44 cells, the average weight being about 1,500 pounds and the battery-charging room holding, when full, more than 750 tons of batteries.

Running over the entire length of the battery-charging room is a Morgan traveling crane having a span of 41 feet. The crane is provided with grappling hook-arms for the easy handling of the battery boxes, and is operated from a platform at its centre. The crane movements are elaborately interlocked for safety. Like nearly all of the other auxiliaries of this station the crane is provided with duplicate motors, so that in case of failure of one the other may be put in service. Running crosswise of the battery-charging room are six transfer railways, these being operated by wire rope cables driven by winding motors on the floor above. The transfer railways run from the level of the battery-room floor, which is slightly below that of the loading room, in tunnels or passages under the floor of the latter. The cars of the train are of skeleton type so that the hydraulic plunger used in lifting the batteries up to the level of the cabs on the loading floor above may pass through them. The loading room has a number of broad doorways opening into Forty-ninth street and contains six loading stands, elevators for sending vehicles upstairs and inspection pits. Of the six loading stands, four are equipped to take care of vehicles whose batteries are loaded at one end, while two are to handle the underslung-battery vehicles. In the older type of loading stand the necessary alignment of the vehicle for the reception of its battery was performed by hydraulic buffers operating upon the hubs of its wheels. An ingenious automatic device is now used, called by the men about the place the "ferry-slip" centering device. The vehicle is guided by converging channels against which the ends of its hubs work, and it runs upon a sectional floor, best understood by reference to the illustrations herewith. This permits a side movement of the vehicle without sliding its wheels sidewise on the floor. When the vehicle has come as far as it can go on this stand the hydraulic buffer rises beneath it and takes the weight of the vehicle body off the springs, so that when the battery is withdrawn the body will not rise. The apparatus for removing and replacing a battery is excellently shown in one of the illustrations. It consists of a horizontal hydraulic cylinder, the piston of which is armed with hooks so arranged as to engage in catches upon the battery box of the incoming vehicle and withdraw it upon the platform of the plunger coming up through the charging train in the tunnel below. When the battery is pulled out on this the horizontal plunger is withdrawn and the platform lowered until the battery rests on the train. The latter is then moved forward so that a new battery is brought over the elevating device which lifts it into position for insertion in the vehicle. A forward motion of the horizontal plunger suffices for this and the vehicle is charged, the whole operation, from its entrance to the building to its complete reloading ready for departure, having consumed something less than two minutes.

This station enjoys the distinction of being the largest as well as the most completely equipped automobile charging station in the world. Throughout, the most careful attention has been paid to details and to the duplication of all important parts of the apparatus as an absolute safeguard against stoppage of the service owing to any accidental breakdown. This is noticeable in such cases as the hydraulic pumps supplying water under pressure to the numerous hydraulic auxiliaries, the air pumps for pumping vehicle tires, the electrical charging arrangement in full, and in a multiplication of units for transportation and handling. The company is to be congratulated upon the great perfection of its service in all the numerous details that make for success.

BATTERY-CHARGING RACKS IN THE NEW YORK ELECTRIC VEHICLE TRANSPORTATION COMPANY'S STATION

Winners of the 100-Mile Automobile Endurance Test on Long Island.

Messrs. Fred Walsh and H. S. Chapin were awarded blue ribbons on April 21 by the committee of the Automobile Club of Long Island, their machines having been declared winners in the 100-mile endurance test held by the club on Saturday over Long Island roads. Red ribbons were awarded to Messrs. H. B. Baruck, E. F. Grueter and C. J. Field; yellow ribbons went to F. A. Low and A. L. McMurtry for vehicles making 30-minute stops. Three silver cups were awarded in the hill-climbing contest and were won by Messrs. Low, Grueter and Field. Charles Meyers and E. Uppercue, who made the run in a trifle over five hours, were disqualified for excessive speeding, the first prizes going to Messrs. Walsh and Chapin.

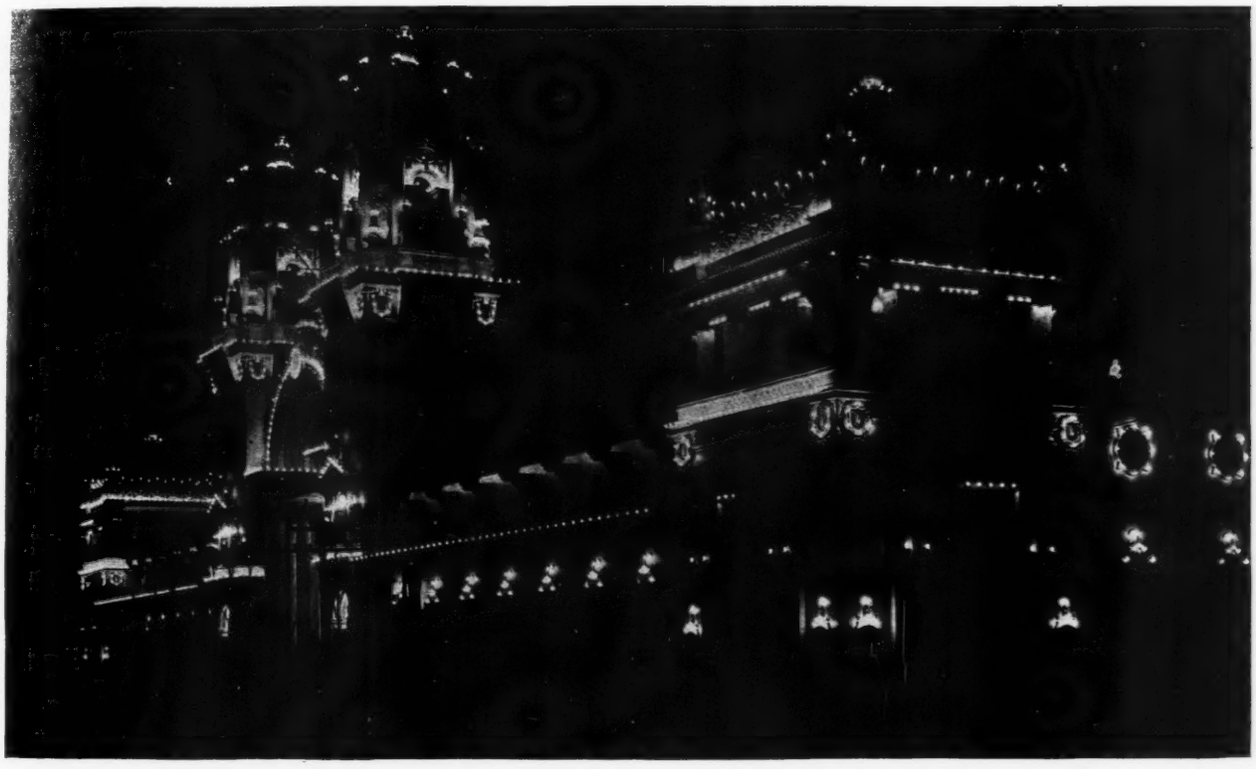
The Pan-American Exposition.

Its General Features and Details of Electrical Interest. In Two Parts.

Part I.

THE GROUNDS AND BUILDINGS—ARCHITECTURAL AND DECORATIVE FEATURES—THE COURT OF FOUNTAINS AND ESPLANADE—THE ELECTRIC TOWER AND FOUNTAINS—POWER AND LIGHTING PLANT—THE ELECTRICAL TRANSMISSION FROM NIAGARA FALLS.

ELECTRICITY is the key-note of the Pan-American Exposition. In every direction upon the ample grounds is to be seen evidence of electrical application, either for the silent and economical production of motive power for the numerous purposes of the exposition, or in the wonderfully beautiful decorative lighting effects which make this the most elaborate exhibition of electrical illumination that has ever been witnessed.



THE FIRST ILLUMINATION OF THE ELECTRICITY BUILDING AT THE PAN-AMERICAN EXPOSITION.

The Pan-American Exposition is the outcome of an idea that has been growing for 12 years, or since the visit of the delegates of the various nations of the two Americas to this country in 1889. As long ago as 1897 a company was incorporated to undertake the holding of an exposition which should exhibit the industrial, artistic, scientific and social progress of the peoples of North and South America, at a point upon the frontier between the United States and Canada. The project, delayed by the outbreak of the Spanish war, was taken up again with renewed ardor upon the termination of that conflict, and with ample funds, secured from the United States Government, the Government of New York State, the municipality of Buffalo, and subscriptions from no less than 11,000 private subscribers—funds sufficient to assure the success of the enterprise upon a large scale. The grounds were selected adjoining Delaware Park, the most important and beautiful of the parks surrounding Buffalo, north of that city and between it and Niagara Falls. Here, in a land and water area roughly a mile long by half a mile wide, are located the buildings of the exposition, and are assembled the various exhibits which make it representative of the countries of the Western Hemisphere; exhibits justly entitling it to the name Pan-American.

Next to the abundant use of electricity for all purposes perhaps the most striking feature of the exposition is its architecture.

In seeking for an architectural *motif* that should fitly characterize an American exposition it was determined, after some study on the part of the board of architects having the matter in hand, to use the style of the Spanish structures erected on this continent during the period when most of it was a colonial possession of Spain; and this idea, though much modified by the exigencies of the case, has been carried out in some detail. While great freedom was allowed the individual architects, unity of appearance has been carefully preserved, both in the detail of the design of the individual structures and in the grouping and massing of the buildings, to produce an effect of astonishing magnitude and exceeding beauty.

Color has been freely employed in the adornment of the buildings. The prevailing tone of the staff, walls and columns, is an ivory or yellowish white color, while the roofs are in general of deep red tiles. The details of many buildings have been set out in color, and the jewel-like domes of the Temple

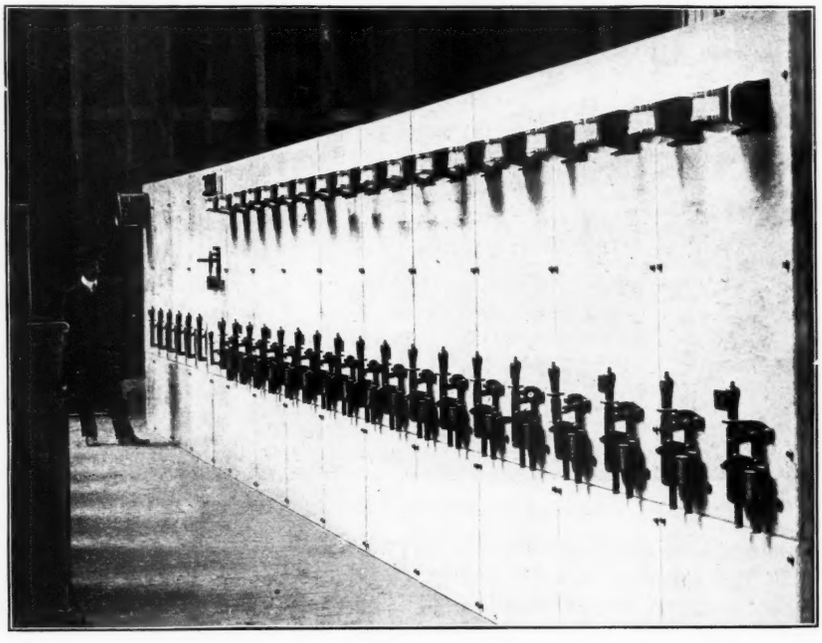
of Music and the Ethnology Building, which form portals to the noble Court of Fountains, are brilliant in turquoise blue and other colors suggesting enamels.

The central point of the exposition—the dominating structure and the one that gives character to the whole arrangement—is the superb tower nearly 400 feet high rising from a semi-circular colonnade and resting in a broad basin of water, which will be the scene of gorgeous displays of electric lighting and color. The Electric Tower, as this structure is called, is the most striking and memorable feature of all those that are gathered in the exposition grounds. For its illumination no less than 40,000 incandescent lamps are employed, their arrangement being such as to point out all the details of the graceful architecture of the tower. This tower stands at the head of the Court of Fountains, which is formed by the four great structures of the exposition, the Electricity, Agricultural, Machinery and Transportation and Manufacturers' and Liberal Arts buildings. At the foot of this court stand the very beautiful Music and Ethnology buildings, the court here widening into an immense esplanade closed at its two ends, respectively, by the United States Government's exhibit building and the buildings devoted to horticulture, graphic arts and mining. In line with the Court of Fountains and forming an approach to the esplanade is a monumental approach of great beauty and dignity, which forms really the entrance to the exposition. Behind the Electric Tower is a sunken garden beautifully adorned with sculpture, the vista in this direction being closed by the Propylæa, a curved colonnade of much felicity of architecture, forming a screen for the railway station which is immediately behind it. The court surrounding the sunken garden is flanked on its two sides by restaurant buildings in the Spanish mission style of architecture.

One of the End Pavilions of the Electricity Building.

Everywhere throughout the grounds, upon the cornices and sky lines of buildings, along the more important horizontal divisions of all these structures, in groups and clusters, and, in short, wherever it is possible for them to add to the beauty of the night scene, are to be found incandescent lamps. Truly the electric lighting of the grounds and buildings of this exposition will be the most extraordinary spectacle of its kind that has ever been presented, that at Paris last Summer having been small in comparison.

In the extreme northwestern corner of the grounds stands the service power-house, in which are 3,500 horse-power of generating apparatus operated by steam engines. This power-house, like other parts of the exposition, has grown since its original inception. It was planned originally as a service plant for the direct-current lighting and power necessary during the work of constructing the exposition, but now furnishes light for the interior of the buildings and motive power through the grounds. All of the decorative lighting is furnished by current from the Niagara Falls plant transmitted to the exposition grounds. The installation in the power-house is a part of the general exhibit of engines and dynamos, and consists of one 180-kilowatt 135-cycle Warren single-phase alternator; one 300-kilowatt 60-cycle Stanley two-phase generator; one 180-kilowatt 60-cycle Westinghouse two-phase generator; four 225-kilowatt 500-volt and two 90-kilowatt 110-volt Westinghouse direct-current generators, and a complete arc lighting plant of Thomson-Houston machines, all driven by engines of the Phœnix and Buffalo Forge companies' types. The plant being of a temporary character, all of the units are belted to the engines, no direct-coupled machinery being installed in this section.



Switchboard in the Electricity Building for Handling the Current Received from Niagara Falls.

In addition to the electrical equipment of the power-house it contains also a complete air-compressor plant for operating the pneumatic switches and signals along the tracks of the New York Central & Hudson River Railroad's belt line (which will be the principal means of access to the exposition), and an ammonia compressing plant for supplying the refrigerating apparatus in the various restaurants scattered through the grounds. It contains also exhibits of fire pumps made by the Snow Steam Pump Works, valves made by the Fairbanks Company, and belts by Charles A. Schieren & Company, Fayerweather & Ladew, Bickford & Francis Belting Company and the Chicago Belting Company.

The decorative lighting is fed from Niagara current at 25 cycles per second through appropriate transformers which will be described below. The water and lighting effects of the Electric Tower and the basin in front of it are upon a scale of great magnitude and produce results of surprising beauty. Installed in the Machinery and Transportation Building, as part of an exhibit, are 12 rotary pumps made by the P. H. & F. M. Roots Company and having a joint capacity of 35,000 gallons per minute. The pumps are operated by exhibit engines made by the American Engine Company, Bound Brook, N. J.; Murray Iron Works, Burlington, Iowa; Lane & Bodley, Cincinnati, Ohio; Ames Iron Works, Oswego, N. Y.; Harrisburg Engine Company, Harrisburg, Pa.; Fitchburg Steam Engine Company, Fitchburg, Mass.; Watertown Engine Company, Watertown, N. Y.; Struthers, Wells & Company, Marinette, Wis.; National Meter Company, New York, N. Y.; Bessemer Gas Engine Company, Grove City, Pa.; J. L. Alberger & Son, Buffalo, N. Y. Their total output—over 25,000,000 gallons in the 12 hours they work each day—feeds the great cascade that pours down from a point 60 feet above the basin on the front of the Electric Tower. For this cascade the water is brought in two 10-inch headers at a pressure of 110 pounds per square inch and discharged in numerous small jets and sheets against a curved baffle plate or deflector which throws it downward in a broad sheet. This sheet of water, striking several obstructions in its way down, is broken into numerous cascades and ripples, and wherever it is possible there has been installed a powerful projector arranged to throw light of various colors into the mass of falling water. No less than seventy-six 12-ampere arc lamps are installed in the basin in front of the Electric Tower, while eighteen 35-ampere lamps are also used in the electric cascade effects. In addition to these the basin is surrounded by powerful searchlights fed from a plant in the Machinery Building and arranged to focus their beams upon the descending water. The plant for this purpose consists of two Keystone generators of large size, one direct-coupled to an Erie-Ball engine, and the other belted to a Skinner engine, an Onondaga

THE ELECTRIC TOWER AT THE PAN-AMERICAN EXPOSITION. PHOTOGRAPHED ABOUT APRIL 15, 1901.

Dynamo Company's machine direct-coupled to a straight line engine, and an American Ball Company's direct-coupled unit. The plant also takes care of the enclosed arc lamps burning on direct current in the four main buildings grouped around the Court of Fountains.

Design for the Pan-American Exposition Diploma.

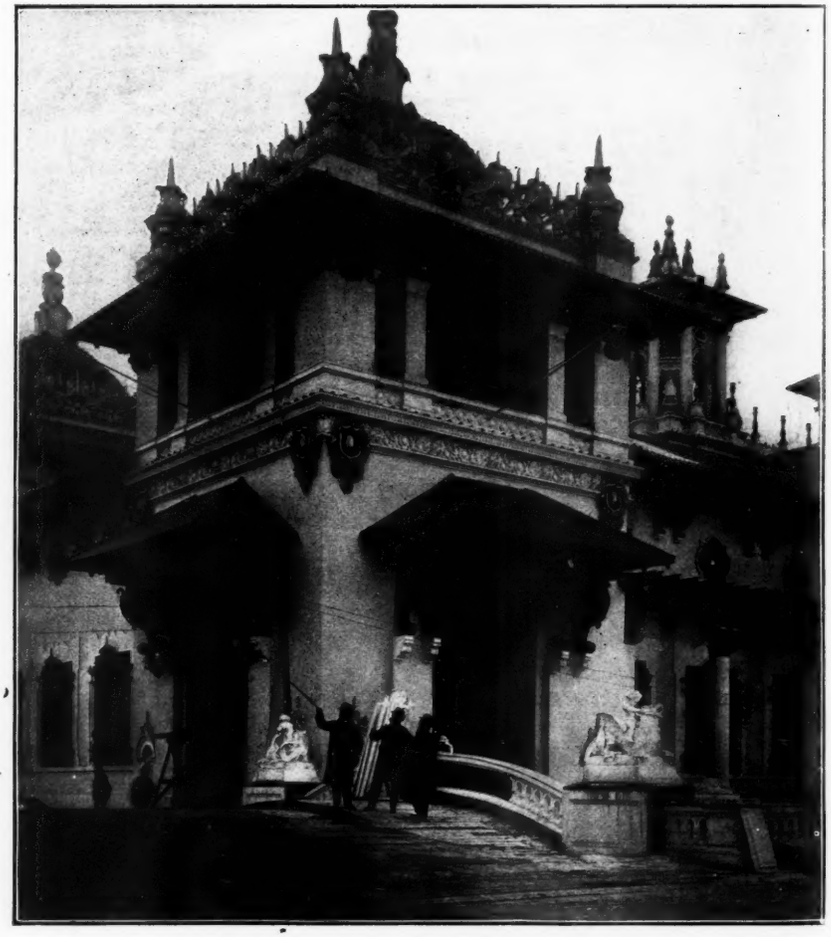
Forming a part of the General Electric Company's exhibit in the northwestern corner of the Electricity Building, is the group of transformers in which the Niagara current is received for the purposes of the exposition. A minimum of 5,000 horse-power has been arranged for; the current comes from the terminal station in Niagara street in Buffalo upon six cables, each of 300,000 circular mils, the voltage at the receiving transformers being about 11,000 volts. In the transformer station, which is shown in one of the accompanying engravings, are 18 air-blast transformers each of 225-kilowatt capacity, these serving to reduce the line pressure to 1,800 volts at which it is distributed throughout the grounds to other transformers which reduce it to 104 volts for feeding the various groups of lamps. The blowers for these transformers are mounted under the floor and are, of course, operated by electric motors. The switchboard is of blue Vermont marble, with silver trimmings, and carries oil switches operated by pneumatic power.

Despite a number of vexatious and embarrassing delays, due to continuous rain and an unseasonable and heavy snowstorm in the month of April, the exposition was thrown open to the public on May 1. The formal opening, however, will be held on May 20, when the exposition will be dedicated with proper ceremonies, in which the presidents of the various American republics and the Governor-General of Canada will participate, either in person or by means of electric connections. By that date it is believed that everything about the grounds and buildings will be complete and in working order.

Below is given a list of exhibitors in the Electricity Building. This building and its contents will be described at length in following articles.

LIST OF EXHIBITORS IN THE ELECTRICITY DIVISION, PAN-AMERICAN EXPOSITION.

American Elec. Telephone Co., Chicago, Ill.
American Vitrified Conduit Co., New York.
Arnold Elec. Power Station Co., Chicago.
Bell Telephone Co., Buffalo, N. Y.
E. G. Bernard Co., Troy, N. Y.
Bettini Phonograph Co., New York, N. Y.
Bossert Electric Construc. Co., Utica, N. Y.
Bullock Electric Co., Cincinnati, Ohio.
H. B. Camp Co., Akron, Ohio.
Clark Auto. Telephone Co., Providence, R. I.
Crocker-Wheeler Co., Ampere, N. J.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
P. B. Delaney, Orange, N. J.
D'Olier Engineering Co., Philadelphia.
Edison Manufacturing Co., Orange, N. J.
Electric Storage Battery Co., Philadelphia.
General Electric Co., Schenectady, N. Y.
Gould Storage Battery Co., Depew, N. Y.
B. & E. Hanfield, New York.
Hazard Manufacturing Co., Wilkesbarre, Pa.
Holophane Glass Company, New York, N. Y.
Incandescent Elec. Lt. Mfg. Co., Boston, Mass.
Jandus Electric Co., Cleveland, Ohio.
Eldridge R. Johnson, Philadelphia, Pa.
Keystone Electric Co., Erie, Pa.
Lea Manufacturing Co., Elwood, Ind.
S. S. McClure & Co., New York.
John T. McRoy, New York.
Mann Brothers, Chicago, Ill.
Mason Monogram Co., New York.
Morris Electric Co., New York.
National Auto. Telephone Co., Chicago.
National Carbon Co., Cleveland, Ohio.
National Gramophone Co., New York.
Northern Electric Mfg. Co., Madison, Wis.



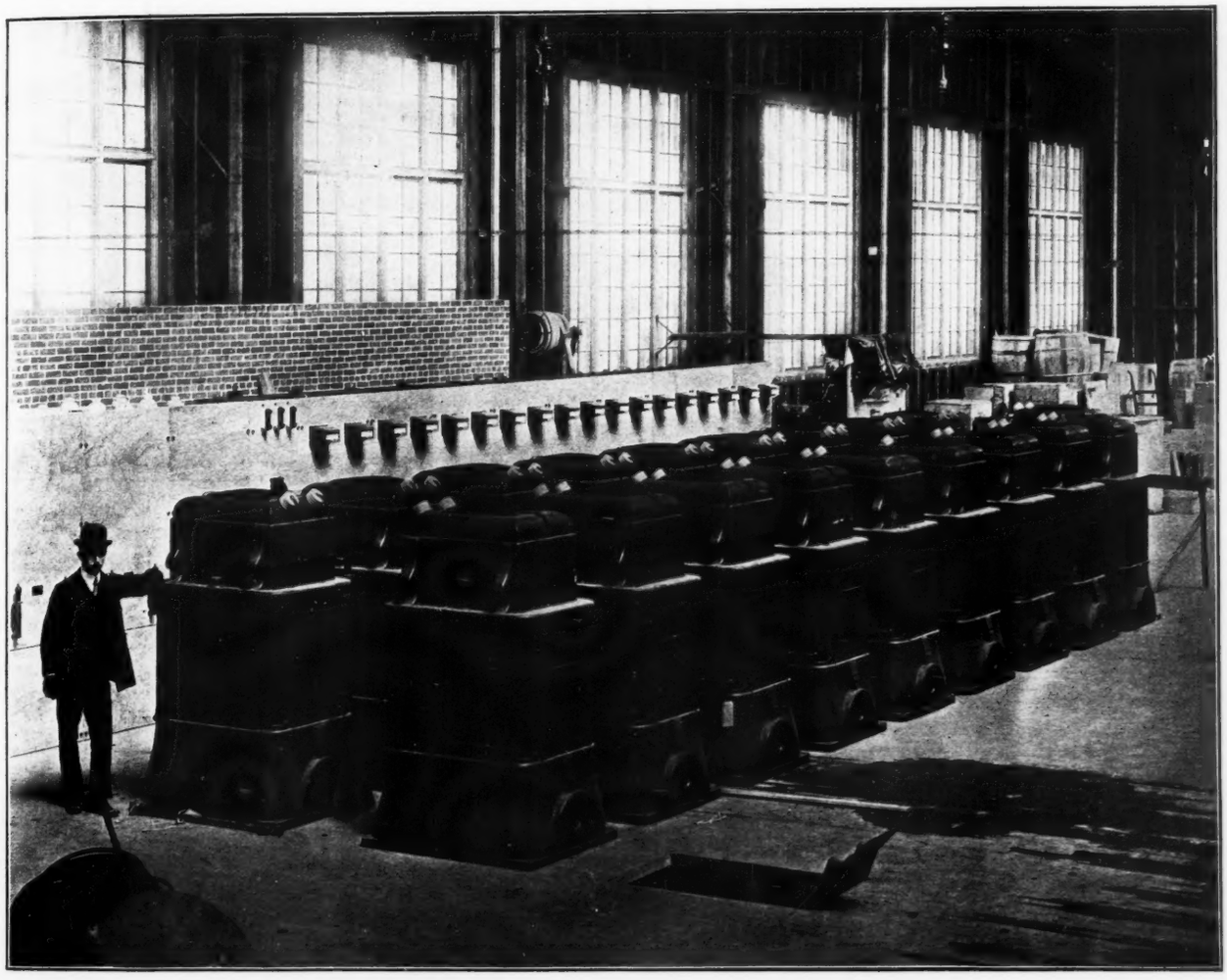
A Corner Pavilion of the Electricity Building.

Onondaga Dynamo Co., Syracuse, N. Y.
F. C. Perkins, Buffalo, N. Y.
Peru Elec. and Mfg. Co., Peru, Ind.
C. B. Rowell, Buffalo, N. Y.
Safety Insulated Wire Co., New York.
Standard Underg. Cable Co., Pittsburgh, Pa.
Stanley Elec. Mfg. Co., Pittsfield, Mass.
Stanley Inst. Co., Great Barrington, Mass.
Stromberg-Carlson Tel. M. Co., Chicago, Ill.
Submerged Elec. Motor Co., Menomonee, Wis.
Syracuse Elec. Inst. Co., Syracuse, N. Y.
C. J. Toerring Co., Philadelphia, Pa.
R. V. Wagner & Co., Chicago, Ill.
Waite & Bartlett Mfg. Co., New York.
Western Electric Co., New York, N. Y.
Westinghouse El. and M. Co., Pittsburgh, Pa.
White, The O. C., Co., Worcester, Mass.

Changes in the Metropolitan Street Railway, New York City.

President Herbert H. Vreeland, of the Metropolitan Street Railway Company, of New York city, said recently that his company is ready to begin work on most of the changes proposed on the various lines which it had under consideration for some time. The company has, however, made some changes in its working plans, as in the instance of connecting the Broadway with the Madison and Third avenue lines at the post office. It was intended to begin that work this Spring, but instead of this it will not be attempted at all until after the work on the rapid transit tunnel in that district has been completed. The first operation to be undertaken in the near future will be an extension of the Sixth and Eighth avenue lines to the Cortlandt street ferry. The downtown lines of these roads now run through West Broadway and Fulton street into Church street, while the ferry extension will run down from West Broadway, through Fulton street, into Washington, and thence into Cortlandt street to the ferry. On the streets which will be occupied by these extensions a line of horse cars is now operated by the company, and when the change is completed patrons of the company will be able to arrive at the Cortlandt street ferries without the necessity of transferring. Work began on these lines on April 8.

At Canal street work will be begun on connecting the Sixth and Eighth avenue lines as soon as the rail connections, which have been made to order, are received, and it is said that their arrival is expected every day. Somewhat later, probably in May, the Broadway and Lexington avenue lines will be changed over from cable to the electric system, and by about the first of June these lines will be in operation. When these changes are accomplished a considerable saving will result to the company from the abandonment of the various power stations, as the entire system will be fed from the new power-house at Ninety-sixth street and the East River, the present power-houses at Broadway and Houston street, East Twenty-fifth street, and Sixth avenue and Fiftieth street, being used as substations, where the current from the central station will be step-down and converted.



GROUP OF EIGHTEEN TRANSFORMERS RECEIVING 11,000-VOLT NIAGARA CURRENT FOR THE DECORATIVE LIGHTING OF THE PAN-AMERICAN EXPOSITION.

Wilholz Telephone Co., Buffalo, N. Y.
Eureka Tempered Cop. Wks., North East, Pa.

In the "Collective Exhibit," which will be in charge of Mr. W. J. Marland, the following exhibitors will show electrical appliances:

Charles J. Bogue, New York.
Edison-Johnson Electric Mfg. Co., New York.
Dunn-Martin Electric Co., New York.
Thomson Electric Welding Co., Lynn, Mass.
H. C. Cushing, Jr., New York.
Prentiss Clock Improvement Co., New York.
Speer Carbon Co., St. Marys, Pa.
F. B. Sage & Brother, New York.
The Diamond Arc Lamp Co., Mt. Vernon, N. Y.
Harold P. Brown, New York.
Emilie J. Tardie, New York.
H. P. Cameron Elec. Mfg. Co., Boston, Mass.
William Roche, New York.
Smith & Hemingway, New York.

THE DISTRIBUTION AND CONVERSION OF RECEIVED CURRENTS—II.

BY HENRY GORDON STOTT.

The five cables shown in Fig. 5, connecting the terminal house with the substations, are all of the three-conductor type; that is, have three 000 B. & S. gauge copper cables separately insulated under one lead covering, the three insulated conductors being twisted into a rope, and the interstices filled with jute yarns to give an even round surface for the lead to rest on.

Three of these cables are insulated with a wall of nine-thirty-seconds inch rubber mixture having 30 per cent of pure Para rubber; one has a wall of one-quarter inch rubber mixture with 40 per cent pure Para, and the fifth cable has on each conductor thirteen-sixty-fourths inch paper, and around the three insulated conductors an additional belt of thirteen-sixty-fourths inch paper. All the cables have a lead jacket one-eighth inch thick, over all the outside diameter of cables being approximately two and three-eighths for the rubber and two and five-eighths for the paper.

Experience with the first four cables seems to indicate that a rubber insulated cable with nine-thirty-seconds inch wall, 30 per cent pure Para, is perfectly reliable for 11,000 volts, but that one-quarter inch insulation even with a high percentage of pure Para is not.

The 18 miles of paper insulated cable having only recently been installed, no conclusions can be drawn with safety, but as there are about 30 miles of the rubber-covered cables which have been installed for from two to three years, the above conclusions would seem to be drawn from experience with a sufficient amount of cable to justify confidence in its reliability.

In the sketch showing the cable system it will be noticed that at several points "oil switches" are indicated; these are installed in water-tight iron boxes in the manholes, in such positions as to break the cables into sections of about one mile in length, so that in the event of trouble the fault may be readily localized and the bad section switched off in the manholes without interfering with the rest of the cable.

Glazed tile conduits are used, and have proved, when dry, to be an effectual safeguard against electrolysis, the only cases of trouble from the latter having occurred in manholes in which the cables were submerged in water. Considerable trouble was caused for a time by the breaking down of the rubber near the end of the lead covering where the cables were connected to the switchboards, and investigation showed that this was caused by the ozone generated by the static discharge taking place from rubber to lead, but this has been overcome by wiping on a large brass cable head to the lead sheath and thus greatly increasing the distance between rubber and grounded sheath, the cable head being filled with insulating compound poured in hot, a hard-rubber separator keeping the rubber-covered conductors away from the brass whilst the compound was solidifying. Reference to the diagram, Fig. 5, will show that a further precaution has been taken at the two most important substations, Nos. 1 and 3, to prevent interruption due to cable trouble, *viz.*, to run loops from all cables into them instead of taps. By this means, if a fault should simultaneously develop in a section of one cable between these stations and in a section beyond either of them, cross-connections can be made very rapidly and easily by means of which no cable will be overloaded for more than the short period necessary to make these cross-connections.

To sum up: The means adopted for protection to the distributing system are:

1. Time element overload circuit-breakers.
2. Reversed current circuit-breakers.
3. Sectioning switches in manholes.
4. Loop switches in principal substations.

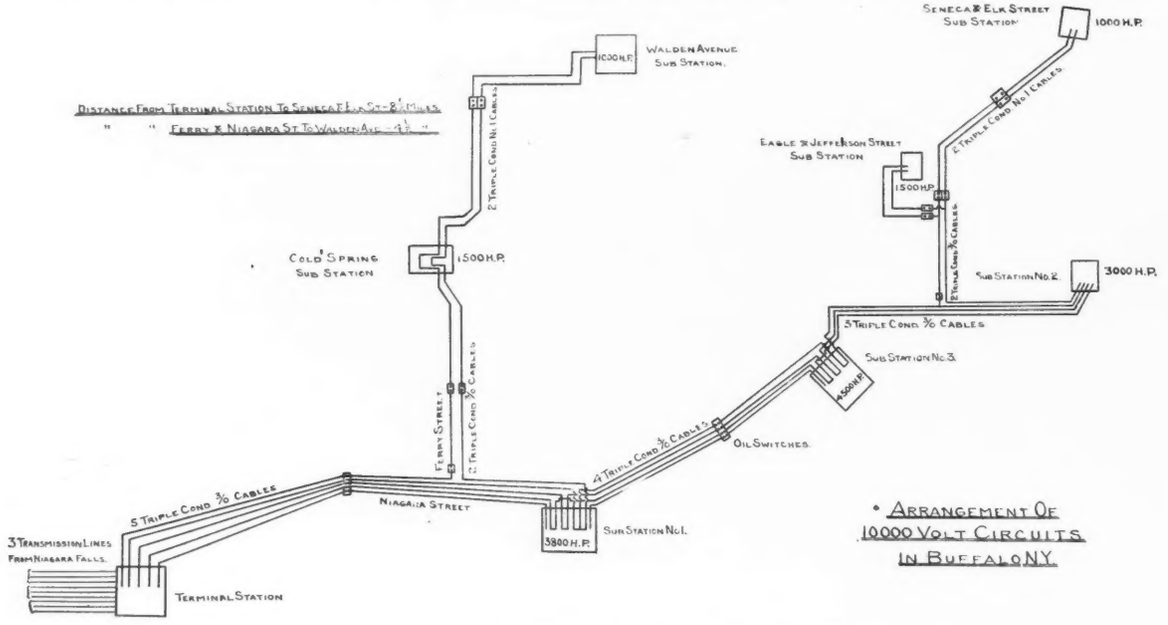

Seneca & Elk Street Sub Station
1000 H.P.
Walden Avenue Sub Station.
1500 H.P.
Distance From Terminal Station To Seneca & Elk Sts. 2½ Miles
" " Ferry & Niagara Sts. To Walden Ave. 4½ "
2 Triple Cond. No. 1 Cables
Eagle & Jefferson Street Sub Station
1500 H.P.
2 Triple Cond. No. 1 Cables
Cold Spring Sub Station
1500 H.P.
2 Triple Cond. ⅜ Cables
Sub Station No. 2.
3000 H.P.
5 Triple Cond. ⅜ Cables
Sub Station No. 3.
4500 H.P.
Ferry Street
2 Triple Cond. ⅜ Cables
4 Triple Cond. ⅜ Cables
Oil Switches.
5 Triple Cond. ⅜ Cables
Niagara Street
3 Transmission Lines From Niagara Falls.
Sub Station No. 1.
3800 H.P.
Terminal Station
* Arrangement Of 10000 Volt Circuits In Buffalo N.Y.

FIG. 5.—DIAGRAM OF HIGH-TENSION CIRCUITS IN BUFFALO, N. Y.

CONVERSION.

The 11,000-volt, 25-cycle, three-phase current distributed to the seven substations in Buffalo is manifestly unfit for use in the supply of power or light without transformation in the former and conversion in the latter case, as 25-cycles is much too low a frequency for arc lighting, which promises to displace incandescent lamps to a great extent in the near future.

In discussing the various means employed to make this power available to the customer, we will begin with the simplest and then proceed to the more complex. The simplest and most efficient method is evidently to reduce the pressure by means of static transformers of large capacity and high efficiency and deliver three-phase 2,200-volt current to the

various customers by means of a secondary network of cables. This is done in substations Nos. 1, 2 and 3, where 2,200-volt three-phase current is delivered by underground and overhead cables to customers for use in malt houses, grain elevators, machine shops, dry docks, bakeries, tanneries, and all sorts of manufacturing establishments to the extent of about 4,000 horse-power. This power is utilized in the above places chiefly by means of induction motors, some of which receive the current directly at 2,200 volts, but in the majority of cases at a reduced pressure of 440 or 220, the reducing transformers being supplied by the customer. For grain elevators, in which a large amount of fine dust of an explosive nature is present, the induction motor presents an ideal solution of the power problem, as the safety and controlling devices can be located in a separate building, so that no spark can cause an explosion or fire. The efficiency of transformation with this system is evidently that of the transformers only, which in sizes of 250 kilowatts and upwards is from 97.5 to 98.3 per cent at full load.

The largest user of power in Buffalo is the International Traction Company, which receives a total of 7,000 horse-power in five substations, No. 1, Cold Springs, Walden avenue, Eagle and Jefferson streets, and Elk and Seneca streets, where the power is distributed to their 550-volt direct-current feeders after being transformed from 11,000 volts to 375 volts and converted in rotary converters to 600 volts direct current.

An interesting comparison is the relative efficiencies and cost of static transformers and rotary converters as against motor-generators receiving the 11,000-volt current direct into the motor, and converting it into 600 volts direct current by means of a generator coupled to the same shaft, and is given in the following table:

EFFICIENCIES: 200-KILOWATT UNITS.

	Transformer.	Rotary.	Combined.	Motor.	Generator.	Combined.
Full load.....	97 5	93.0	90.67	95	92	87.4
¾ load.....	97.1	92.5	89.81	94	91	85.54
½ load.....	96.0	90 0	86.40	92	88.5	81.42

From the above table it will be seen that the transformer and rotary converter give 3.27 per cent at full load, 4.27 per cent at three-quarter load and 4.98 per cent at one-half load better efficiency than the motor-generator set.

The investment shows a saving in favor of transformers and rotary converters of about 19 per cent, so that for purposes such as railroad work, where no great refinement of regulation is required, the rotary is beyond doubt the best and most economical.

A view of a substation is given in Fig. 6, which is typical of all; the incoming current enters a three-pole oil switch, which is known as an emergency switch, and from there branches to several oil switches, each of which controls the primaries of three 150-kilowatt static air-blast transformers connected in delta; the secondaries, also delta-connected, go direct to the collector rings of a 400-kilowatt rotary converter, so that the three static transformers and rotary converters form one unit, being in fact started from the direct-current end and synchronized by means of small potential transformers on the 11,000-volt primaries.

To provide for the emergency of a total shut-down of the power circuits, those substations which have no storage battery auxiliary from which direct current may be got for starting the rotaries, a small motor-generator set is installed, consisting of a 30-horse-power induction motor direct-connected to a 20-kilowatt 600-volt direct-current generator. This set is supplied with alternating current by means of a three-phase oil-cooled transformer, reducing the pressure from 11,000 to 375 volts; as soon as the power is on the cables the induction motor is started, the small direct-current generator is connected to the bus-bars and one of the rotaries started and synchronized in the usual way, after which the motor-generator set is shut down and the remaining rotaries started from the first. From the five substations distributing power to the direct-current feeders great economy of distribution is obtained and an equality of pressure at practically every point of the system, which would be practically impossible with a single plant with 550-volt feeders covering the same distance. Storage batteries are installed at substations No. 1, Cold Springs and Eagle and Jefferson, having a total capacity for one and one-half hours of 2,400 horse-power at 575 volts. They are used principally to help carry the peak load between 5 P. M. and 6.30 P. M. and to take up part of the extreme fluctuations of load through differentially wound boosters.

We now come to the last and most interesting plant connected to the transmission system in Buffalo, *viz.*, that of the Buffalo General Electric Company, the transformer house of which is marked "Substation No. 3" on the sketch showing cable system, in which 4,000 horse-power

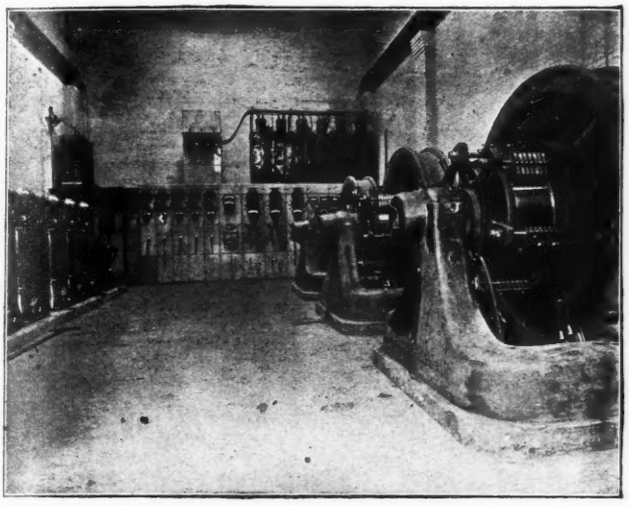


FIG. 6.—A TYPICAL ROTARY CONVERTER SUBSTATION.

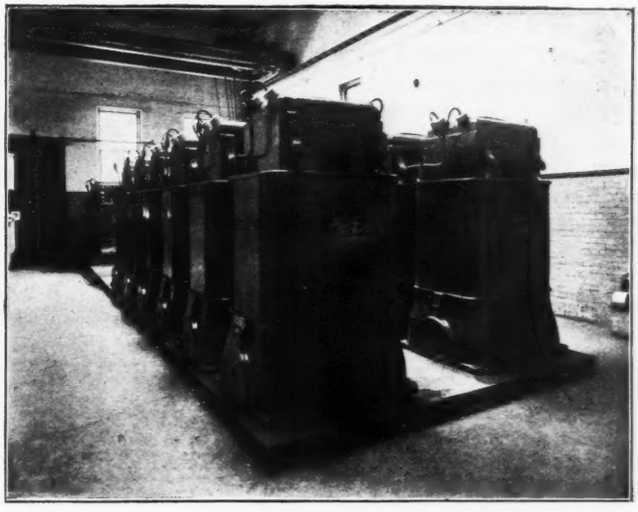


FIG. 7.—TRANSFORMERS IN SUBSTATION NO. 3.

is received from the power company, and after being transformed to 360 volts is converted, by means of motor-generator sets, rotaries, etc., into four different kinds of service—constant continuous current for street arc lighting, 60-cycle quarter-phase current for incandescent and arc lighting in the more remote districts, three-wire 220-volt continuous current for the downtown district, and 550-volt continuous current for power to motors, elevators, etc.

The transformer house, built as an annex to the main station, has 12 250-kilowatt transformers, reducing the three-phase 11,000-volt current to three-phase 360 volts. The transformers (see Fig. 7) are arranged in two rows instead of three as usually in order to facilitate the rapid exchange of one in case of trouble. By arranging them in this way the transformer has only to be raised half an inch by the hand-crane and then run out of the way to make room for the spare one, an operation requiring only an extremely short period compared to that necessary to lift the transformer over the others. The transformers stand over a brick air-chamber 30 feet by 9 feet by 7 feet high, into which three two-horse-power induction motors direct-connected to air-blowers force cool air, giving an even pressure of about half an ounce in all parts of the chamber. Access is had to the air-chamber through double air-tight doors, so that a man can work on the terminals or connect up a new group without interfering in any way with the air supply. Iron shelves on the outside of the brick walls of the air-chamber form supports for the primary cables leading to the switchboards on the one side and for the secondaries on the other, giving wide separation for safety, similar to those in Fig. 8.

The transformers are connected to the primary and secondary switchboard panels by rubber insulated and lead-covered cables; each transformer is wired single-phase to the panels, the delta-connection being made after passing through spring expulsion type aluminum fuses on the primary side, and ordinary long break aluminum fuses with barriers on the secondary side, so that in the event of a transformer burning out it will cut itself out of circuit without affecting the other two of the same group.

The secondary current, after going through the usual recording and indicating instruments, terminates in three heavy copper bus-bars, extending the full length of the secondary board, to which are attached the cables bringing the current into the main building of the Buffalo General Electric Company.

In adopting the secondary voltage of 360, a number of points were taken into consideration, the principal one being that a large and healthy day load of 550-volt direct-current motors was being supplied at the time steam was used for motive power, and could not well be discontinued, so that voltage was adopted which would permit of rotaries being run without any further transformation. This pressure besides being very safe for cables and motors, is a very economical one to build for, as it permits of the use of bar winding on all sizes, and as all motors are of the revolving field type, the question of carrying heavy current in the collector rings was left out. The only additional cost due to the low pressure was in the cables within the plant, and this was more than balanced by the saving in a further transformation for the 550-volt rotaries and in the additional safety of bar winding *versus* wire.

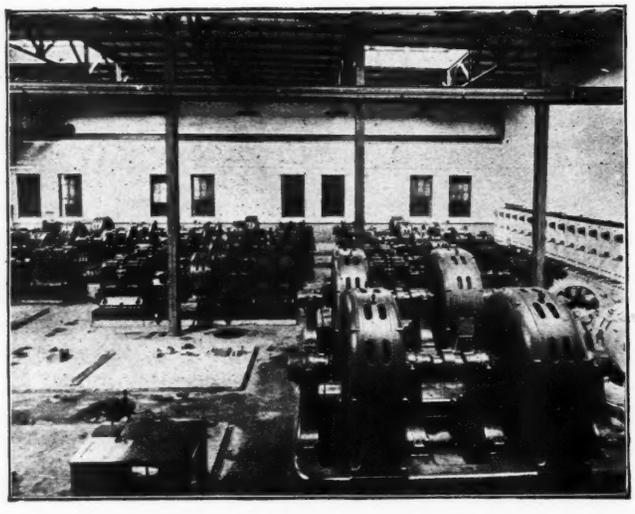


FIG. 9.—POWER-HOUSE OF THE BUFFALO GENERAL ELECTRIC COMPANY.

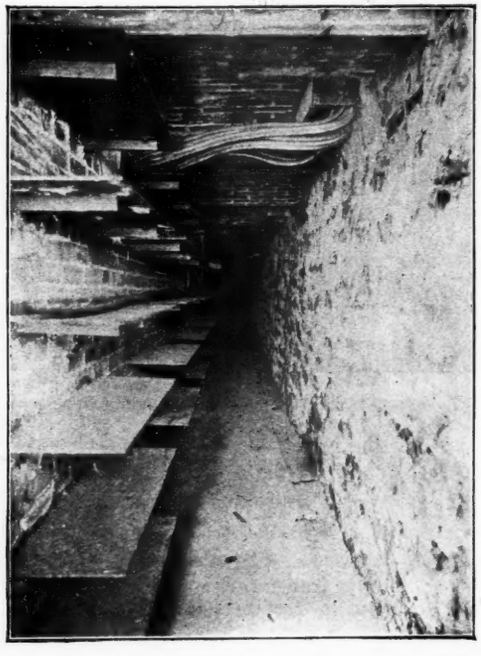


FIG. 8.—ARRANGEMENT OF CABLES IN AIR-CHAMBER.

The power-house, Fig. 9, is a building 91 feet by 91 feet, having a row of columns down the centre, each half of the building being spanned by a crane traveling the full length with transfer points from one crane to the other.

In this building having 8,281 square feet of floor surface are installed 6,460 horse-power in motors, 6,073 in generators, and 600 horse-power in rotaries, a total of 13,133 horse-power in electrical machinery, giving a floor space of 0.63 square foot per horse-power or 1.24 square feet per horse-power of generating capacity including all regulating apparatus, switchboards, etc.

A Combination of Copper Companies.

Messrs. John D. Rockefeller, H. H. Rogers, James Stillman, Thomas W. Lawson and Lewisohn Brothers are reported to be endeavoring to form a combination of their various copper interests with Senator Clark, of Montana, the idea being to combine all the companies under one head and to sell through the United Metal Selling Company, which it is believed will reduce expenses and enable the business to be carried on at a greater profit. The capital stock of the companies which will probably be in the new corporation aggregates $211,250,000. The companies' names and the amounts of their respective capitalizations follow: Amalgamated Copper Company, $100,000,000; American Smelting and Refining Company, $100,000,000; Calumet & Hecla Mining Company, $2,500,000; United Verde Junior Copper Mining Company, $3,000,000; Boston & Montana Consolidated Copper and Silver Mining Company, $3,750,000; Butte & Boston Consolidated Mining Company, $2,000,000. The National City Bank, of New York city, will be the depository of the new organization, and will finance the project.

MODERN TELEPHONE ENGINEERING—I.*

BY KEMPSTER B. MILLER.

The subject which you have assigned to me, "Modern Telephone Engineering," is one of such breadth that only portions of it can be treated in a single evening, and those portions not with as great an amount of detail as I would desire.

After careful consideration, I have concluded that the subject matter which is most likely to interest the greatest number of those present is a discussion of a few of the engineering problems arising in planning a telephone exchange, and also a description of some of the methods and means employed in what may be considered modern telephone practice. Time will not permit me to deal with the various items in detail, and therefore these remarks should be regarded in many cases rather as suggestions than as complete treatments of the various points.

The statements which I wil' make in the course of the evening will relate to what I believe to be good telephone practice, regardless of whether it is the practice of the Bell or of the independent companies. The circuits shown are those of the Bell company, and the apparatus mostly that of the Kellogg Switchboard and Supply Company, with which company I am connected. I trust that I may be pardoned for appearing partial to the apparatus of this latter company; but, in the first place, my brethren under the wing of the Bell company have not exhibited an undue amount of enthusiasm in the matter of furnishing me with cuts and data thereon. In the second place, I have been closely identified with the design and the manufacture of the Kellogg apparatus and am therefore better able to talk of it. In the third place, I think that most of the telephone engineers here are perhaps as familiar, if not more so than I am, with the apparatus of the Bell company, and therefore will be more interested in that of another make. Be this as it may, whatever methods, circuits and apparatus are described will be typical of the telephone art as it exists to-day

The first problem arising when a telephone exchange is to be installed in a large city is that of the number, size and location of the central office or offices. The proper solution of this problem depends in all cases upon local conditions, and can be attained only after much consideration and calculation.

If the cheapest were the best, the telephone engineer would experience comparatively little difficulty in exactly determining the location of the telephone office or offices, as well as the boundaries of the office districts in any city, after having canvassed the communities and ascertained the topographical location of the present and prospective subscribers. The most important consideration is that of the quality of service to be rendered. This factor, "quality of service," can not be expressed in dollars and cents; it must be left to the good judgment of the engineer to so construct the telephone plant that the demands made by the public are satisfied without making the plant so expensive as to be an unprofitable investment.

Other matters to be considered in the preliminary layout of a system are:

Annual cost of operation, including salaries of operators and the cost of current supply; fixed charges and rent, interest and depreciation on the office equipment, interest and depreciation on the wire plant, interest and depreciation on the subscribers' apparatus and annual cost of maintenance. These factors, unlike the first mentioned, are subject to predetermination with a fair degree of exactness.

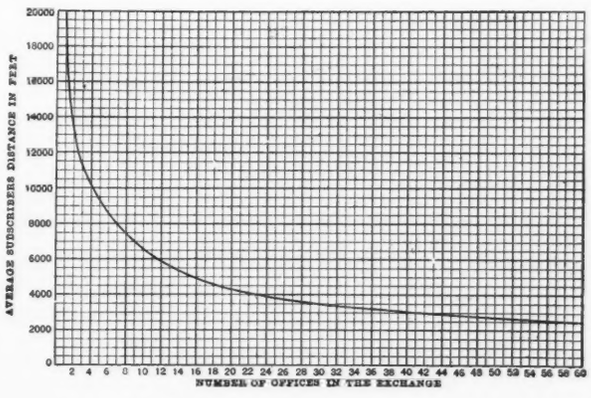


FIG. 1.—DOMMERQUE'S CURVE.

A brief discussion of each of these various factors as to their bearing on the number and location of offices will probably be of interest.

I think it is a well-established fact that the best telephone service can be given where all the lines of the subscribers in a city run to a single exchange and are there handled by a single multiple switchboard. By this means, all calls for connections by any subscriber may be handled by a single operator. Where the number of subscribers, however, is too great to be connected to a single switchboard, or where the distribution is such as to naturally group them about well-defined and remote centres, a greater number than one exchange must be installed and lines provided between them for connecting the subscribers in the different exchanges. Such lines are called trunking lines, in distinction to subscribers' lines, which connect the subscriber with the central office.

In most cases where trunking is necessary, most calls have to be trunked. I believe the percentage of trunked calls to total calls for Greater New York is in the neighborhood of 80. A connection made over a trunk line necessarily occupies more time and thereby renders the service a little slower. In fact, the aggregate time required for connection over a trunk line is practically twice as great as where accomplished by a single operator in a multiple board. The fact that two operators necessarily handle a trunk connection necessarily increases the liability to error in making the connection, and therefore produces less satisfactory service. The trunking apparatus and circuits, in order not only to transmit speech, but to convey the requisite signals between the operators, are necessarily more complex than subscribers' line circuits, and thereby a greater liability to trouble exists than where no trunks are required.

So far, therefore, as the question of quality of service is concerned, there can be no question but that a single large office serving all of the subscribers in a given city is best.

Again, if we consider only operating expense, a single office serving the entire city is best. First, because in a single office the total number of operators required is a minimum (it has been amply proven by experience that this is so); second, in a trunking system the number of higher paid persons than operators will be greatly increased, as there will be, for instance, a manager, a wire chief, a chief operator, etc., for each of the different offices; third, the item of current supply is naturally higher with several offices than with a single large one, as the power system requires more current on account of the greater amount of apparatus and also on account of the machinery being split up into smaller units and working with less efficiency.

The item of fixed charges and rent includes the salaries paid to the general management, the business and engineering offices, as well as rent. The former items

* A paper read before the New York Electrical Society.

should not differ materially whether one office or a greater number is used. The question of rent, however, is a little more complex and must be accurately determined for each particular city. It will vary from 50 cents to $2 per annum for every square foot of floor space. Where a single office is used this is necessarily located somewhere in the centre of the city where rent is highest. Where a number of offices are used, the offices will not be in the centre of the city, but will of necessity be at points densely populated. The probabilities are that the rental, which will also include light, heat, elevator service and janitor service, etc., will be slightly cheaper for a large office located in the heart of the city than for several smaller offices located in the most densely populated portion of their respective districts.

The interest and depreciation on the office equipment is in most cases smaller for the single office system, for while it is true that a single large multiple board costs more than a number of smaller multiple boards having the same aggregate capacity as the large one, yet the addition of the trunking apparatus to the smaller boards, and the fact that the power plants, manager's, wire chief's, monitor's and trouble clerk's desks and similar apparatus are duplicated at each exchange, will probably throw the balance in favor of the single large exchange. This matter, however, would need to be determined for each set of conditions, as it can not be said in all cases the office equipment for a single exchange would be cheaper than that of a greater number of exchanges furnishing service to the same number of subscribers.

All the factors so far considered—that is, the quality of service, the cost of operation, fixed charges and rent, and depreciation on the office equipment—seem to lean in favor of the single office, some of them decidedly so, others not so strongly. Against these must be put, in some cases, the interest and depreciation on the wire plant and the item of annual cost of maintenance.

By wire plant is understood everything pertaining to the telephone plant, from the subscriber's premises to that point in the telephone office, or offices, where the lines enter the terminal heads. It therefore embraces the underground conduits and cables, the pole lines carrying cables or bare lines, together with all necessary apparatus, such as manholes, drop wires, etc.

It is easy to see that the average length of subscribers' lines will be greatest when a single office is used, and will steadily decrease as the number of offices is increased. It has been pointed out by Mr. F. J. Dommerque, that in a given community the average length of subscribers' lines varies inversely as the square root of the number of offices. In other words, if the average length of subscribers' lines with one office is L, then the average length of subscribers' lines with N offices is approximately $L^1 = \frac{L}{\sqrt{N}}$. This law is not strictly true, but gives a close approximation. Mr. Dommerque, in planning the reequipment of the system of the Chicago Telephone Company on an ultimate basis of fifty thousand (50,000) subscribers, found that the average length of line for the city of Chicago, if equipped with one exchange, would be twenty thousand (20,000) feet. From this figure and from the law of variation just stated, the curve shown in Fig. 1 has been plotted, giving the average length of subscribers' line for any greater number of offices up to 60. It was found that the actual measurements of subscribers' lines for the various proposed layouts for the city of Chicago closely coincided with the figures of this curve, so closely in fact that such a curve was found to be a practically reliable source of information for any number of offices. A similar curve might be plotted for trunk lines and order wires connecting such offices, which curve would, of course, start with a zero ordinate for one office and rapidly rise with the number of offices.

It is interesting to conceive these curves, when carried to their limits; that is, when there were 50,000 central offices for 50,000 subscribers. The curve of subscribers' lines would then have a zero ordinate, while the curve for the trunk lines would have a maximum ordinate which would be equal in feet to the distance from one subscriber's station through all of the other subscribers' stations. This means that there would be no subscribers' lines whatever, but that from each subscriber's station there would be a trunk line corresponding to every one of the 49,999 other stations, as these trunk lines would extend through all stations. We have an actual example of such a system as this in the ordinary house telephone system, where every subscriber has his own central office and where every subscriber's line extends to every other subscriber.

If there is but one exchange in the city, the proper location for it may be found by marking upon the map all of the subscribers, present and prospective, and then determining the centre of gravity of the system, so to speak. This may readily be done by drawing a straight line through the map in such a manner as to have one-half of all the subscribers on one side of it and the other half on the other. In a similar manner another line may be drawn at right angles to the first, bisecting the total number of subscribers, and the intersection of these two lines will probably be fairly close to the proper place for the central office.

A remote group of subscribers, not cut by these two lines, would tend to draw the true centre of distribution from the point so located toward it. In order to avoid errors from this source a number of other pairs of bisecting lines should be drawn, the lines of each pair being at right angles. Three such pairs of coordinates, 30 degrees apart, would locate three centres, probably close together, and the centre of the triangles formed by these centres is a very close approximation to the centre of distribution of all the subscribers.

With this location determined, it is an easy matter to determine the total average distance of the subscribers from it, and therefore the total wire mileage of the subscribers' lines. With the average subscribers' distances as the base, a curve such as just shown may be plotted, which will show in a close enough degree of approximation what the average length of subscribers' line would be for any other number of central offices.

Of course, as the number of offices increases, the wire mileage of the trunk lines and order wires increases, and figures concerning this must be worked out in consideration of the locations of the various offices and the amount of traffic between them. This latter factor, the traffic between offices, varies greatly according to the kind of districts connected, and it is therefore almost impossible to give general figures as to the mileage of trunk lines and order wires. It may be said, however, that the statistics of the large cities of this country and Europe show that the trunk and order circuit wire mileage is approximately one-fifth of that of the subscribers' wire mileage. It is evident that this figure can be used as a basis for laying out new exchanges, for, by the very nature of things, there can be no definite ratio between the two.

If it is found necessary for any reason to divide the system up into office districts, a great amount of care must be taken as to the proper boundaries for these districts. Of course, rivers, water fronts and railroads will frequently aid in the determination of these boundaries. There

is frequently a tendency toward the use of large business streets and thoroughfares as boundary lines between districts, but investigation will show that in many cases this is not good practice, as such streets or thoroughfares should be the centres of distribution rather than the boundaries of them. Diagonal thoroughfares between offices should be used as trunk-line routes, rather than boundaries of districts, owing to their directness and to the fact that a large number of subscribers are usually located in their vicinities.

Having decided on the boundaries of the districts, their respective centres may be determined, and between these the most available routes for trunk lines determined.

In figuring the cost of the wire plant for various layouts of a city, it will not do to assume the cost to be in direct proportion to the wire mileage required by the systems using one office, or a greater number, for there is a factor entering the problem which greatly favors the single office, or, I might say, greatly favors the fewer number of offices. This factor is due to the fact that with the single office system, or with the system using few offices, a greater amount, in proportion, of large conduit and cable may be used, and therefore the cost per conduit-foot per mile will be considerably smaller than where a greater number of offices are used.

In general, it may be said that the interest and depreciation on the wire plant decreases as the number of offices increases, and this is the main, and, in fact, practically the only, item to offset the advantages of the fewer number of offices or the single office.

The interest and depreciation on the subscribers' apparatus would be the same whether one or many offices were used.

A limitation to the size of switchboards has heretofore necessitated a greater subdivision of offices in very large cities than any of the considerations so far pointed out would warrant.

Until recently, it has been the policy of the Bell Telephone Company to establish no central offices having switchboard capacity for over 6,000 lines. This limit was maintained because of the fact that it has not been practicable to build multiple switchboards having a larger capacity than that. This limit in the capacity of the board has been due entirely to mechanical rather than electrical conditions, and on account of it, it has been impracticable to build such exchanges as those of New York and Chicago with a single office, if other conditions had warranted it.

RIGHTS OF ABUTTING OWNERS AS AGAINST TELEPHONE AND TELEGRAPH COMPANIES.*

BY G. C. HAMILTON.

The introduction of the electric telephone and telegraph evoked many new questions of the law of real property. The general demand for a method of rapid intercommunication in the business and social world lead to the widespread dissemination of such lines, and, with general and increasing construction, the erection of poles and the placing of wires, caused, in a measure at least, some detriment to the fee of the adjoining landholder. Upon many of the questions that have thus arisen the courts have held widely divergent views, but the general tendency of decision has been to afford companies constructing and operating telephone and telegraph lines as wide a latitude in their operations as is consistent with a proper interpretation of the laws governing real property. That telephone and telegraph lines may be, for all general purposes of the law, considered one and the same, there can be no longer any question. Stephens, J., says:[1] "I do not think it necessary to express any opinion on a controversy which is more scientific than legal, and perhaps more properly metaphysical or relative to the meaning of words than scientific, as it seems to turn upon the nature of identity in relation to sound. It is enough to say that whatever be the merits of the controversy, it does not appear to us that the fact, if it is a fact, that sound itself is transmitted by the telephone, establishes any material distinction between telephonic and telegraphic communication, as the transmission of it takes place and is performed by a wire acted on by electricity." And Brown, J., says:[2] "We see no reason to doubt the position assumed by the complainant that a telephone company is a telegraph company." This ruling seems to have been generally accepted and widely followed.[3]

Primary among the questions that have been raised by the abutting landowner is that concerning the subordination of the highway to the use of telephone and telegraph circuits. Is the erection and maintenance of such a line a use to which the highway may properly be subjected? or are the poles and wires a novel and improper use, foreign to the purpose for which the easement was acquired, and a new and additional burden upon the fee? Here the courts are at issue, and the opinions, each logical and of weight, widely divergent. Devens, J., says:[4] "The use of a portion of the highway for the public use of companies organized under the laws of the state for the transmission of intelligence by electricity, and subject to the supervision of the local municipal authorities, which has been permitted by the legislature, is a public use similar to that for which the highway was originally taken and to which it was originally devoted." The argument in this line of decisions would seem to be that the public streets are not limited in their use to the purpose of passways, or avenues for travel, but may be subjected to every use which promotes public convenience and comfort and is not inconsistent with the use to which they were originally dedicated.[5] It is further argued in those cases where this view has been taken, that the occupation of the streets by poles and wires takes nothing which the laws reserved to the original proprietor of the land, when the public easement therein was acquired, nor does it appropriate it to a use not within the public easement.[6] That where land has once been duly appropriated to a public use, which requires the occupation of its whole surface, and is applied by legislative authority to another and similar use, no new claims for compensation unless expressly provided for can be sustained by the holder of the fee;[7] and so the erection of telephone poles and wires upon the public highway, in states where these views are held, does not impose upon the land a novel and additional servitude entitling the holder of the fee to additional compensation therefor.[8]

The contrary view is ably expressed in the opinion of Allen, J., in what may be termed one of the leading cases upon this subject, Pierce *vs.* Drew.[9] Here the learned judge, dissenting from the view of the majority of the court, says: "If it is incident to the laying out of a highway that a telegraph line may thereafter be established upon it, by the sanction of a future board of municipal officers, this right must of necessity be paid for at the outset, unless the owner of the land will have a subsequent claim for additional damages; otherwise his property is taken from him without compensation. It is going quite too far to hold that in law it must be deemed to have been within the contemplation of the parties at the time of the laying out of the highway that it might be used for such new and additional purposes. They are in their nature essentially distinct from the ordinary use of the highway by travelers. It is not desirable to impose this new and additional

* From the *Central Law Journal*. Citations referred to will be found on page 561.

burden upon the laying out of highways. If the public convenience and necessity require a new highway, but do not require a line of telegraph over it, the public authorities ought to be able to take such an easement as will subserve the public requirement without being subjected to the necessity of paying for a right which is not needed nor desired. The use of a highway for telegraphic purposes is not naturally included in the original design, nor naturally incidental to its use for travel. Highways can be and are conveniently used without telegraphs or telephones. The latter can be established without the use of the highway. It may be convenient in many instances to use the highway for electrical lines. Whenever this proves to be the case, there is no hardship in requiring those who wish to establish such lines to pay for the privilege such damages, if any, as may be caused to the owners of the property by such use."

Where this view is taken, the argument would seem to be that the power of the legislature over the streets is confined strictly to the use for which they were taken; that as trustee no greater title is taken than is necessary to the proper execution of the trust, and that, as the construction and maintenance of telephone and telegraph lines upon the highway do not come within the terms of a trust confined strictly to the protection of the public easement in the streets, a legislative franchise to companies, organized for the transmission of intelligence by electricity, permitting such construction, is void and inoperative as against abutting owners.[10] It is held that the erection of poles and wires under legislative sanction, without the consent of the adjacent owner, who retains the fee in the highway, comes within the constitutional inhibition, "private property shall not be taken or damaged without just compensation."[11] Condemnation of land for the public use as a highway gives, it is argued, only the right of passage over it. The absolute property therein remains in the holder of the fee, and this is restricted and interfered with by the erection of poles and wires in or upon the land. The state does not possess this right, as trustee for the easement; it can not, constitutionally, grant it to another.[12] A franchise to erect a telephone or telegraph line upon the public highway, in such a manner as not to incommode the public in its use, may be granted, but such lines form no part of the equipment of a public street, but are foreign to its use, and where the abutting owner holds the fee to the middle of the street he is entitled to extra compensation for the additional burden placed upon his land.[13] In short, a telegraph or telephone company is regarded as a public use only in the sense that the public, by payment therefor, may become possessed of certain rights which the law will enforce. The true question at issue is whether or not the erection of poles and wires upon the highway constitutes an additional servitude upon the fee and so entitle the landowner to extra compensation therefor. There can, properly speaking, be no distinction between cases where the fee to the middle of the street is in the abutting owner, and those where it is in the public.[14] It is impossible to lay down any exact rule as to the circumstances that will justify the exercise of the power of eminent domain as against abutting landowners, or the holder of the fee in general.[15] For the purposes of this article we can merely examine the general principles. The use must be public, but it is not necessary that the public of an entire community be benefited by the use; a local use is undoubtedly sufficiently public.[16] So the condemnation of a right of way for a telephone company, whose operations were to be purely local, would be a proper exercise of the power of eminent domain, since public use and public benefit or utility are, in this connection, synonymous.[17] It is essential, however, that the user, or right of user, be in the public, and that this be the improvement for which the private property is taken, consequently it is necessary that the service of telephone or telegraph companies, seeking to acquire right of way for the erection of poles and wires, be available to the public of the locality in which the right of eminent domain is sought to be exercised, or at least available to the public in general.[18] The fact that the property of the individual so taken is bestowed upon a private person or corporation, and that private emolument and gain result from the use, will not prevent the exercise of the power in the case of telephone and telegraph companies as against abutting owners, since the use is public and public benefit the object in view.[19] There can, consequently, be no doubt that a telephone or telegraph line for the general transmission of messages is a use, on behalf of which the power of eminent domain may be properly exercised.[20] It has been held, in a recent Texas decision,[21] that a telephone company, organized under a statute providing for "a telegraph and telephone line" which formerly read "a telegraph or telephone" line, is entitled to exercise the power of eminent domain under a statute giving such power to corporations created for the purpose of constructing and maintaining "a magnetic telegraph line."

As to the right of the adjacent owner to compensation for the obstruction of light, air, etc., by telephone and telegraph companies, there can be no question. The abutting owner has redress as against any substantial obstruction of his right of access, or his enjoyment of the use of the street in connection with his land.[22] The right to maintain shade or ornamental trees in front of property is clearly incidental to the ownership of the adjacent fee. In Ohio, where it is held that no additional servitude is imposed upon the land constituting highways by the erection and maintenance of the poles and wires of telephone and telegraph companies, such a company was held to have no right to trim trees, whether such cutting was necessary or not.[23] In Connecticut, where the statute permitting the construction of telephone lines says that trees shall not be injured without the consent of the owner, it has been held selectmen can not give authority to cut trees, even though such cutting be necessary, without the consent of the adjacent landowner.[24] In Mississippi, a telegraph company, constructing under a permit from a county board of supervisors, acting under power conveyed by statute, was held to have acquired no power to remove trees or branches.[25] Where the abutting owner holds the fee to the middle of the street, and the courts view the erection of telephone and telegraph poles and wires as a new servitude upon the fee, it would seem that the trimming of trees and hedges entitles the abutting owner to compensation, if done without an express license from him.[26] On the other hand, even though the adjoining owner so holds the fee, if the poles and wires be considered no new burden upon the highway, and a use not foreign to the public easement therein, then a municipality granting a franchise to a telephone company, when acting under its powers to provide for public uses, grants therewith the power to do the necessary trimming of trees and hedges adjacent to such line,[27] a similar view being taken by the federal court.[28] Where the cutting is unnecessary or malicious, or where the trees are wantonly injured, as by the careless use of linemen's "climbers," the company is liable, certainly, for the damage actually sustained, and, in certain cases, even puitive damages may be obtained.[29] This would seem to be the rule, even though the cutting by the company's agents be in direct violation of its expressed orders.[30] As to the re-

strictions placed upon the adjoining owner, in his use of the fee, by reason of the proximity of telephone or telegraph circuits upon the adjacent highways, there are none save those to which he is subjected generally. The maxim of the law, *"Sic utere tuo ut alienas non laedere,"* applies equally well in the cases of companies for the transmission of intelligence by electricity against abutting owners. The freeholder can maintain upon his land anything to which he may, at common law, subject the fee, and he is liable only when he does not make "use of the means which the progress of science and improvement have shown to be the best" to prevent injury to another.[31] Kekewich, J., says:[32] "I can not see my way to hold that a man who has . . . called into special existence an electric current for his own purposes, and who discharged it into the earth beyond his control, is not as responsible for damages as he would have been if he discharged a stream of water. . . . I hold that if it finds its way onto his neighbor's land and then damages the neighbor, the latter has a cause of action."

The court, in the case of the Hudson River Telephone Company *vs.* Watervliet Turnpike and Railroad Company,[33] says: "We are not prepared to hold that a person, even in the prosecution of a lawful trade or business upon his own land, can gather there by artificial means a natural element, like electricity, and discharge it in such volume that, owing to the conductive properties of the earth, it will be conveyed upon the grounds of his neighbor with such force and to such an extent as to break up his business or impair the value of his property, and not be held responsible for the resulting injury. . . . It can not be questioned that one has a right to accumulate water on his own real property and use it for a motive power, but he can not discharge it there in such quantities that, by the action of physical forces, it will inundate his neighbor's land and destroy his property, and shield himself from liability on the plea that it was not his act, but an inexorable law of nature that caused the damage. . . . If he collects for pleasure or profit the subtle and imperceptible electric fluid, there would seem to be no hardship in imposing upon him the same duty which is exacted of the owner of the accumulated water power—that of providing an artificial conduit for the artificial product, if necessary to prevent injury to others."

So the erection and maintenance of plants generating or using electricity and employing a grounded return circuit to the detriment of telephone or telegraph lines upon the adjacent highway render the owners of such plants liable for all damages that may ensue from such interference, provided that, at a reasonable expense, by the adoption of proper and known appliances, the injury could have been avoided. There is no obligation to utilize devices that are in the nature of experimentation, but if proper means be generally known by which the escapement and consequent conduction may be prevented, the person generating or employing electricity fails to use them at his peril. There can properly be no distinction between the telephone company which, as a rule, from the nature of its business is compelled to make provision for its return circuit, and the person using an electrical current for purposes that do not require such provision.[34]

[1] Atty.-Gen. *vs.* Edison Tel. Co., 6 Q. B. Div. 244.

[2] Cumb. Tel. & Tel. Co. *vs.* United Elect. Ry., 42 Fed. Rep. 273.

[3] Duke *vs.* Telephone Co., 53 N. J. Law, 341; Wisconsin Tel. Co. *vs.* Oshkosh, 62 Wis. 32; Chesapeake & Potomac Tel. Co. *vs.* B. & O. Tel. Co., 66 Ind. 410.

[4] Pierce *vs.* Drew, 136 Mass. 75.

[5] Halsey *vs.* R. T. St. Ry. Co., 20 Alt. Rep. 859; Guy *vs.* Mutual Union Tel. Co., 12 Mo. App. 485; Julia Bldg. Assn. *vs.* Bell Tel. Co., 13 Mo. App. 477; Hewett *vs.* W. U. Tel. Co. (D. C.), 54 Am. Rep. 284; R. R. Co. *vs.* Newark, 10 N. J. Eq. 352.

[6] Magee *vs.* Overshimer, 150 Ind. 127; Taggert *vs.* Ry. Co., 19 Atl. Rep. 326; Williams *vs.* Ry. Co., 41 Fed. Rep. 556.

[7] Atty.-Gen. *vs.* Met. R. R., 125 Mass. 515; Boston *vs.* Richardson, 13 Allen, 146.

[8] Carter *vs.* N. W. Tel. Ex. Co. (Minn.), 40 Cent. L. J. 475; Young *vs.* Yarmouth, 9 Gray, 386; Chase *vs.* Sutton Mfg. Co., 4 Cush. 167; Hewett *vs.* Tel. Co., 4 Mackay, 424.

[9] 136 Mass. 75.

[10] Met. Tel. & Tel. Co. *vs.* Colwell Lead Co., 67 How. Pr. 365.

[11] Board of Trade Tel. Co. *vs.* Barnett, 107 Ill. 507.

[12] W. U. Tel. Co. *vs.* Williams, 86 Va. 696.

[13] Hudson River Tel. Co. *vs.* Watervliet T. & R. R. Co., 135 N. Y. 393; Cin. & I. P. R. R. Co. *vs.* City & Sub. Tel. Assn., 48 Ohio St. 390; Dailey *vs.* State (Ohio), 37 N. E. Rep. 710; State *vs.* Newark, 37 N. J. L. 415; Weller *vs.* McCormick, 47 N. J. L. 397; Broome *vs.* Tel. Co., 42 N. J. Eq. 141; Dusenberg *vs.* Tel. Co., 11 Abb. N. C. 440; Stowers *vs.* Postal Tel. Cable Co., 33 Cent. L. J. 258; A. & P. Tel. Co. *vs.* C., R. I. & P. R. R. Co., 6 Bliss. 158.

[14] Randolph on Em. Dom. Pars. 415, 416; McQuaid *vs.* P. & V. Ry. Co., 18 Oreg. 237.

[15] Olmstead *vs.* Camp, 33 Conn. 531.

[16] Pom. note Sedgwick, Const. of State and Const. law (2 Ed.), 446; Township Board *vs.* Hackman, 48 Mo. 243; Williams *vs.* School Dist., 33 Vt. 271; Hartwell *vs.* Armstrong, 19 Barb. 166; Coster *vs.* Tidewater Co., 18 N. J. Eq. 54; Talbot *vs.* Hudson, 16 Gray, 417.

[17] Salt Co. *vs.* Brown, 7 W. Va. 191; Todd *vs.* Austin, 34 Conn. 78; Dayton Mining Co. *vs.* Seawell, 11 Nev. 191; Bradley *vs.* N. J., etc., R. R. Co., 21 Ind. 294; Great Falls Mfg. Co. *vs.* Fernald, 47 N. H. 456; Hand Gold Mining Co. *vs.* Parker, 59 Ga. 418.

[18] Petition of Mt. Washington Road Co., 35 N. H. 134; Jordan *vs.* Woodward, 40 Me. 317; O'Reilly *vs.* Kankakee Valley Co., 32 Ind. 169; Lance's Appeal, 55 Pa. St. 16.

[19] Anderson *vs.* Tubeville, 6 Cold. 150; Swain *vs.* Williams, 2 Mich. 427; Harris *vs.* Thompson, 9 Barb. 350; Matter of Townsend, 39 N. Y. 171; Concord R. R. *vs.* Greely, 17 N. H. 47.

[20] New Orleans R. R. Co. *vs.* Southern Tel. Co., 53 Ala. 211.

[21] San Antonio & H. P. R. R. Co. *vs.* S. W. Tel. & Tel. Co., 49 L. R. A. 459.

[22] Zehren *vs.* Milw. Elect. Ry. & Light Co. (Wis.), 74 N. W. Rep. 538; Jaynes *vs.* Omaha St. Ry. Co., 53 Neb. 631.

[23] Daily *vs.* Ohio, 51 Ohio St. 348.

[24] Dradley *vs.* South. New Eng. Telep. Co., 66 Conn. 559.

[25] Clay *vs.* Postal Teleg. & Cable Co., 70 Miss. 406.

[26] Board of Trade Teleg. Co. *vs.* Barnett, 107, Ill. 507.

[27] Southern Bell Telep. Co. *vs.* Francis & Allen, 109 Ala. 224.

[28] Southern Bell Telep. Co. *vs.* Constantine (Ala.), 61 Fed. Rep. 61.

[29] Tissot *vs.* Southern Tel. & Tel. Co., 39 La. Ann. 996.

[30] Graham *vs.* Chester Elect. Co., 39 N. Y. Supp. 125; Hoyt *vs.* Southern New Eng. Telp. Co., 60 Conn. 385; Poston *vs.* Cumb. Tel. & Tel. Co., 94 Tenn. 696; Postal Teleg. & Cable Co. *vs.* Lenoir, 107 Ala. 640; Postal Teleg. & Cable Co. *vs.* Brantley, 107 Ala. 683.

[31] Cumb. Tel. & Tel. Co. *vs.* United Elect. Ry. Co., 42 Fed. Rep. 279.

[32] National Tel. Co. *vs.* Baker, 2 Chancery (1893), 201.

[33] 135 N. Y. 393.

[34] Cumb. Tel. & Tel. Co. *vs.* United Elect. Co., 93 Tenn. 492.

A Novel Therapeutic Application of Electromagnetism.

In the office of Mr. John Burry, in New York city, is to be seen an exhibition of an apparatus called the "Magneto Therapeut," which Mr. Burry has developed after a considerable period of research, and which has produced some striking and remarkable results. The instrument, in brief, is a hollow solenoid enclosed in a metallic cover and made in various sizes and lengths adapted for the reception of the various limbs or the whole of the human body. This solenoid is attached to a source of alternating current which causes a somewhat intense alternating magnetic field to permeate its interior and any object, such as the hand or foot, placed in it. Exactly what physiological effect is produced by this action is not known, nor does the inventor claim to be able to explain. He has pursued for some time a course of experiment, observing the effect of this action upon various pathological conditions and has maintained for that purpose what was practically a free hospital for the treatment of painful disorders. The accumulated experience obtained in this way seems to indicate that the action of the apparatus is soothing and tends toward the suppression of painful conditions, especially those caused by defective circulation or malnutrition in muscular and other cells of the affected parts. These conditions exist in rheumatism and a number of kindred diseases. It seems to have been demonstrated, after some thousands of tests on various persons, that the pain and stiffness incident to rheumatic affections disappear after a short treatment and that persistent application induces at least a temporary cure, though the experiments have not continued far enough to state definitely that the cure is final.

It seems also to have been demonstrated that no injury has been caused by the application of this method to any of the numerous patients treated, and while in some cases no beneficial result has been noted, in others marked improvement has resulted, and in some what appeared to be genuine cures have been brought about.

The explanation which Mr. Burry and several of the electrical engineers and physicians who have examined the apparatus have tentatively adopted to account for its action is as follows: If the cells of the body are considered as electrolytic conductors it is evident that their introduction into rapidly alternating magnetic fields will cause local currents to flow in them. Electrolytic action can not take place on account of the rapid reversal of the direction of these currents, but some electro-tonic stimulation doubtless takes place and osmosis is stimulated, thereby tending to restore the normal functions of atrophied cells and blood and lymph vessels. The apparatus is of such simplicity and the results following its application are so marked and interesting that it is believed the invention will attract considerable attention from medical practitioners.

Electric Lighting

Fire completely destroyed the electric lighting plant in the village of Hubbard, Ohio, recently and entailed a loss of about $10,000.

The First National Bank of Crestline, Ohio, and the John A. Roebling's Sons Company, of Trenton, N. J., recently purchased the electric lighting plant at Crestline at sheriff's sale for $16,667, and will continue to operate the plant.

Steps are being taken in Brazil, Ind., for a municipal electric lighting plant, and a corporation in Indianapolis proposes to establish the plant, permitting the city to pay for it at the same rate that it now has for the service rendered by a private illuminating corporation.

It is probable that the streets of Bergen, N. Y., will be electrically lighted in the near future if it is possible for the town to enter into a contract with the superintendent of the illuminating plant at an expense of about $200 a year more than is now being paid for kerosene lighting.

It is reported that the town of Digby, Nova Scotia, may ask authority from the legislature to borrow $40,000 to buy out the electric lighting plants at Digby and Bear River, using the present water power of the Bear River Company to supply the towns named with electric light and power.

The town of Thorntown, Ind., has recently put in operation its electric lighting plant, the first cost of which has amounted to about $12,500 and which will, when entirely completed, have cost $15,000. The system employed is direct-current arc lighting, and the town pays for the plant in installments, at the end of 10 years expecting to own the entire equipment.

A stock company will probably be formed in Clarinda, Iowa, soon with $20,000 or $30,000 capital, to build a new electric light plant to furnish lights throughout the town, as the present plant does not furnish its service except in a limited square in the centre of the city. Among the gentlemen interested in the proposed company are: James H. Dunlap, William Orr, F. J. Tallant and Hugh Miller.

Reports from St. Paul, Minn., state that the Anderson bill, giving to cities of from 10,000 to 50,000 inhabitants the right to run their own electric light plants, passed the house on April 5. The measure brought out sharp debate, one of the senators stating that he thought the bill would introduce into the country districts of the state a law which would be unpopular and where it would be tried only as an experiment. The same gentleman stated that in Minneapolis, where the law had been tried, the provisions of the bill made it one of the worst laws that could be enacted.

At the annual meeting of the stockholders of the Electric Company of America, which was held in Camden, N. J., on April 23, the annual report showed that the net profits for the year 1900 amounted to $410,695; profit from operation of plant, $374,528; other income, $36,167. The total assets of the company, which owns about 15 very productive electric light companies, which are handled from headquarters in Philadelphia, are stated to be $3,810,819. The old board of directors was reelected with the exception that Clement A. Griscom, president of the International Navigation Company, was elected in place of W. J. Latta, resigned.

Reports from Baltimore, Md., state that plans for the organization of the Susquehanna Electric Light and Power Company are being rapidly brought to a finish, and the company will probably be the largest electric power plant in the country next to the Niagara Falls company. Conowingo, Md., will be the seat of the operations and the Susquehanna River at that point will be harnessed as is Niagara and made to furnish power for street railway, lighting and other work in Baltimore, Philadelphia, Wilmington and other places within 100 miles of the river. The company is soon to be incorporated and among the capitalists interested are: John K. Cowen, of the Baltimore & Ohio Railroad, John B. Ramsey, John H. Miller, George McGaw and other Baltimoreans. When the finances of the company are complete $12,000,000 in bonds will have been issued. Twelve to fifteen towns and cities in Maryland and Delaware expect to be supplied with electricity by the company, and negotiations are in progress for furnishing 20,000 horsepower to the United Railways and Electric Company, of Baltimore. The total amount to be expended in the construction and equipment of the plant will be over $5,000,000, and the dam to be constructed across the river at Conowingo will cost $600,000.

Electric Railways

Berkeley, Va., is soon to be connected with Norfolk by direct trolley line, as the Baltimore Street Railway Company has obtained control of the Compostella bridge, which will enable cars to run without interruption from any portion of Berkeley to the centre of Norfolk. In connection with the power plant of the road an electric lighting station will be erected and a lighting service inaugurated over the entire length of the company's system.

An electric railroad is to be built in the near future from some point on the White Pass & Yukon Railway, in Alaska, across the lowest branch of the Yukon River to Hootalinqua River, and thence to the Big Salmon River. The projector of the line, Mr. Wendell P. Jones, of Woodstock, N. B., intends also to extend the system north to Stuart River, and to build a branch to the Hootalinqua and Big Salmon Falls, provided the necessary franchises can be obtained.

The Elgin City, Carpentersville & Aurora Railway Company is conducting negotiations for the construction of a new electric line connecting the cities of Elgin, Batavia, Aurora, Wheaton and intermediate points in New York with Chicago. The main line of the new road will come into Chicago by way of Austin, connecting there with the Metropolitan road, the passengers being there transferred and carried downtown around the loop. When the consolidation and negotiations necessary for the completion of the plan are effected the road will be known as the Aurora, Chicago & Elgin Railway Company. It is said to be backed by capital from Cleveland, Ohio, the negotiations having been carried on through Messrs. M. J. Mandelbaum & Company, of that city.

One of the officers of the Buffalo, N. Y., East Otto & Cattaraugus Railway Company recently stated that the new road is a certainty and that surveys have already begun. The rights of way have been assured and the country people expect that considerably more business will be done when the road is in operation, as Buffalo will be very much more accessible than at the present time. It is announced that the new company will provide freight cars and especially constructed locomotives for the hauling of freight up the steep grades which the line will encounter between the two cities. When the company was organized the capital stock was booked at $800,000, with $50,000 paid in. The officers are: President, H. L. Moench; vice-president and general manager, N. L. Upson; secretary, Theodore Truby; treasurer, W. A. Oakes.

THE NEW EQUIPMENT OF THE SANDUSKY TELEPHONE COMPANY.

BY A. E. DOBBS.

HISTORICAL.

Sandusky, Ohio, was one of the first cities in the country to appreciate the advantages of an independent telephone exchange and to produce capitalists with the necessary nerve to fight the company already strongly intrenched in the field. At that time the older company had an exchange of about 350 subscribers and when, after hard work, a list of something like 300 subscribers was secured for the new exchange it was opened for business in October, 1895.

Right here the company met with a surprise that many other independent managers have met with since then, for it was found that the 300 lines for which the exchange had been wired were totally inadequate to the demands upon it, and the contractor who had installed the plant was hastily called back to add two more sections to the board and build more lines, thus bringing the equipment up to 500 lines capacity. This was efficient for about two years, when it was found that it had outlived its usefulness; for, owing to expiring patents and improved methods of manufacture by the independents, better apparatus could be had. A new switchboard was accordingly purchased, which, while good enough in its day was still not considered good enough for Sandusky, and three months later it was returned to the manufacturer and a later and improved type, containing a self-restoring drop, substituted. By this time there were six sections of 100 drops each, to which two more were subsequently added.

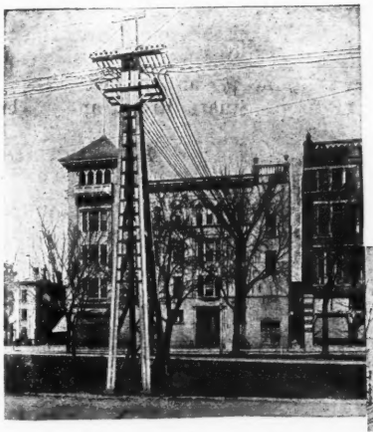


FIG. 1.—CABLE DISTRIBUTING TOWER

All this time the greater part of the management had been vested in a board of directors, who, as the plant grew, came to a realization of the fact, that, to obtain the most efficient and economical service it would be necessary to get a manager who was more familiar with the best telephone practice and its latest developments than themselves. Accordingly that office was given to Mr. Carl C. Curtis, an experienced manager from the older company, who brought with him the latest ideas in telephone construction and management.

After a study of the situation by the new manager and directors, a gradual plan of reconstruction was deemed necessary. The next thing decided upon was to replace the old magneto call system with some form of central battery equipment, and, after long consideration and somewhat spirited bidding by various manufacturers, the contract was awarded to the North Electric Company, of Cleveland, Ohio.

Although the successful bidder had planned such a system, and had built an experimental board to demonstrate its workings, it had not, as yet, been put to a practical test. As both parties to the contract preferred to see the new system in actual operation before undertaking one of this size, it was agreed to postpone the equipment of the Sandusky exchange till a smaller plant could be erected, which was done, and an exchange on the lines laid down was put in operation at Lancaster, Ohio.

FIG. 2.—IRON POLE LINE THROUGH PARK.

The first connection on the Sandusky board was made February 1, 1901, and, in defiance of popular superstition, it was made on Friday at that. But lines and instruments had to be changed to meet the new conditions and it was not till April 11 that the last call came in on the old board. The work of outside construction is not yet entirely finished; many of the cables have had to be overhauled, line routes and instruments changed (copper had already been put up), and all this without interrupting the service; so far, very few calls have been missed.

One of the best construction men in northern Ohio—and that is saying a great deal—has been given charge of this work and the plant will soon be a model of its kind.

Like many exchanges that started in a small way, many of the patrons had got into the habit of calling by name instead of by number; with the new order of things the rule of calling by number was strictly enforced and many amusing stories are told by Mr. Curtis and the chief operator of their arguments with certain irate Sanduskians to convince them that the exchange had outgrown village practices.

OUTSIDE CONSTRUCTION.

Figs. 1 and 2 show the cable lead from the office to the city park and across it. The tower shown in the centre of Fig. 1 is made of structural steel and calculated to stand a strain of 72,000 pounds and is set in solid rock, which, it might be mentioned, underlies all of Sandusky two feet below the surface.

The front, the side shown as front in Fig. 1, is made of two angle irons placed together in each leg, each four by five by three-eighths inches, and the back braces of two angle irons also in each leg, three by six by five-eighths inches. The front braces are set four feet and the back two feet below the surface of the ground, both resting on solid rock and bedded in cement concrete which is further reinforced in front by two 2½-inch expansion bolts passing through a foot-plate five feet further into solid rock, and also cemented in. The distance from the front to the back of the tower is about 12 feet. At present the tower is carrying eleven 100-pair cables, allowing a strain of 2,000 pounds for each cable it will be seen that it will carry several more with safety. The pole line through the park (Fig. 2) is of wrought iron and carries the cables 33 feet above the ground. These poles are also set in cement concrete.

THE SWITCHBOARD.

The present switchboard is of the six-panel multiple type, and, in order to avoid the mistakes formerly made in building on too small a scale, the installation has a frame capacity of 2,400 lines, with 1,000 installed. As the town has a population of about 22,000 this is not excessive, as the improved service is bound to increase the demand. In addition, there are a large number of new subscribers waiting for connections at the present time, but many orders are being held up till the work of outside reconstruction can be completed.

The tendency among manufacturers of

independent apparatus is constantly in the direction of simplicity of parts, which is made necessary owing to the comparative inexperience of most independent exchange owners. Simplicity also increases the life and efficiency of the parts, as a general rule, and is therefore all the more desirable.

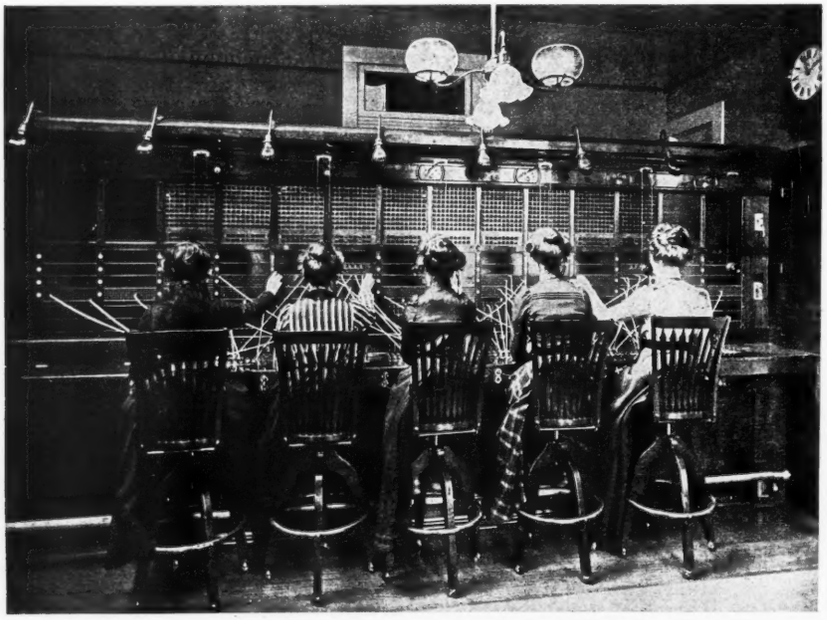


FIG. 3.—REGULAR COMPLEMENT OF OPERATORS HANDLING 1,000 LINES.

To those whose memory of central battery systems calls up banks of relays, condensers and other intermediary devices the present board looks wonderfully simple, being almost as much so as the ordinary magneto call board; the only difference is in the multiple sections and the intermediate distributing board. It is a target (drop) and not a lamp signal board, but it was thought better to sacrifice purely spectacular effects to efficiency.

There is not a relay or condenser in the subscribers' lines anywhere, either in instrument or switchboard, the lines being connected directly to the signal targets, or drops.

One side of the subscriber's line is normally grounded through the ringer magnets, the other being normally open. To call "central" the receiver is removed from the hook, which cuts off the ground, closes the battery circuit and drops the shutter on the board. When the operator plugs in, the target (or drop shutter, if you prefer to call it so) is cut out of the circuit and falls back into place by gravity. When the subscriber wanted is called, another target in the cord circuit is displayed until he answers, when it also falls back into place again. There are two of these targets in each cord circuit, which makes it unnecessary for the operator ever to cut in on a line except to ask for the number wanted.

Should a subscriber be waiting for another to answer his call the signal will be held down until the other party removes his receiver. Should either or both hang up their receivers it would be indicated in the same way and the operator disconnects. Should either wish to call the operator again, moving the hook up and down will signal the operator.

The talking current at the subscriber's instrument is furnished by local batteries and induction coils, as in the ordinary instrument, dry batteries being used for that purpose. As these batteries have a life of from 10 to 18 months in ordinary use they are therefore cheaper than even a storage battery source of supply. In this way the system combines all the advantages of the central battery in automatic signaling—and therefore prompt service—and at the same time retains all the long-distance advantages of the local transmitter battery.

The line signals are actuated by means of eight cells of chloride accumulator, which give a trifle over 16 volts. This low pressure is not only quite a saving, but a distinct advantage over systems running voltages of twice and three times that amount which are a detriment to the insulation of cables and wires alike. The targets are sensitive enough to respond to calls made through a resistance of 1,500 ohms, although they can be adjusted to respond through nearly twice this amount of resistance at even this low voltage.

OPERATION OF THE EXCHANGE.

At the present time each operator's position consists of 200 subscribers' lines,

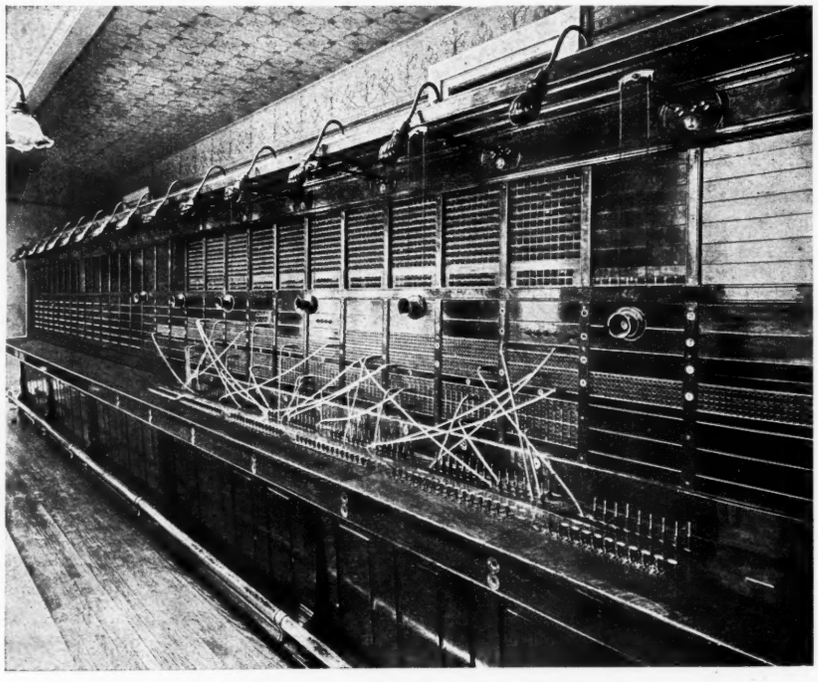


FIG 4 — FULL LENGTH VIEW OF THE SWITCHBOARD.

which is possible only with automatic signaling and an equal distribution of the busiest lines among the various operators at the intermediate distributing rack. By this method it is confidently believed that it is possible for an expert operator to take care of at least 300 subscribers, though this would probably not be advisable.

Operators are not allowed to talk to subscribers—or to each other, for that matter—except to answer calls, and attempts at conversation are turned over to the chief operator and answered from the desk, which has a tendency to discourage the practice. Pilot lights on the board indicate to the chief operator whether calls are being promptly attended to, although they are not really necessary, as, owing to the targets being placed high upon the board, they can be seen from the desk without difficulty. Regular tests by the manager and inspector show an average of a trifle over three seconds as the time of answering calls, which is good service.

In addition to the five girls at the board, there is still another, a relief girl, whose duty it is to take the place of each girl at the board in turns of half an hour each twice a day, each girl being allowed half an hour's recess both in the forenoon and afternoon—a relief that can be best appreciated by those who have sat at a board all day long. The average number of calls from 7.30 A. M. to 5.30 P. M., at the present season of the year, is about 8.9 per line for all lines.

The operators when not on duty have the facilities and comforts of a nicely furnished reading and lounging room adjacent to lockers and toilet rooms. The toll operator has a separate room which is necessary, considering that through the lines of the United States company she has access to over 1,200 stations.

There are several other features of this exchange that add to its efficiency, one of them being a complete intercommunicating telephone system between the manager and the various heads of departments and there are also connections with the terminal room, chief operator, battery room, toll operator, front office and various officials. In this way quicker service and greater secrecy are secured between the different departments.

Another is a plan of observation connections to the chief operator's desk, by which, if, for any reason, the chief operator should desire to make notes of the service rendered on a certain line as, in the case of a "kicking" subscriber, every call will be noted on her desk as well as on the main board.

There is still another feature, known as the "busy back test," which may be interesting. Suppose a subscriber should be called for a toll-line connection who, at the same time, was using his own line. The toll trunking operator inserts a special plug into his multiple jack section so that should any other operator try to call him before he got his toll-line call she would be notified by a buzz that the line was being held for a toll-line connection, which has the right of way.

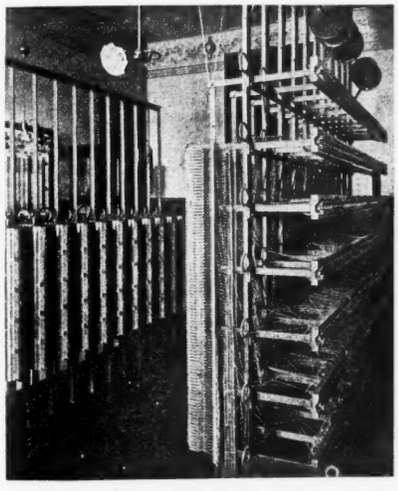


FIG. 5.—TERMINAL ROOM.

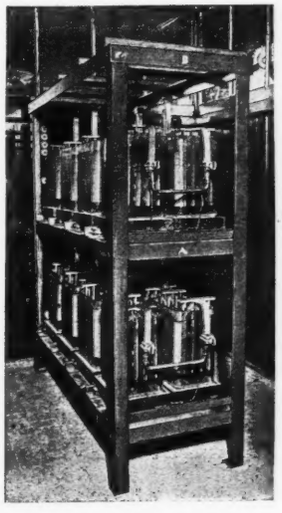


FIG. 6.—BATTERY RACK.

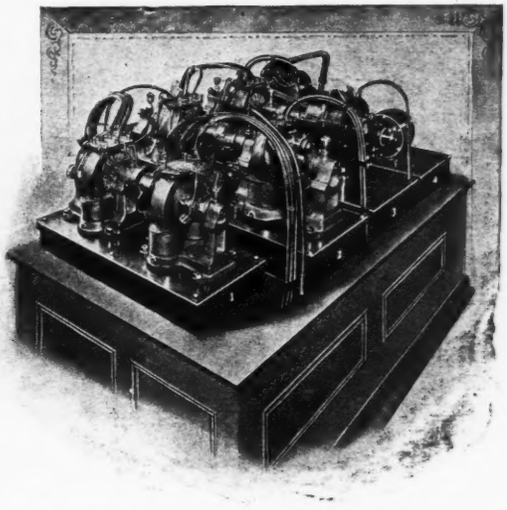


FIG. 7.—POWER AND GENERATOR EQUIPMENT.

AUXILIARY APPLIANCES.

Lines from the outside come in through paper-insulated cables which, about 30 feet from the cross-connecting rack, are spliced to a cable insulated with layers of silk and cotton, encased in lead; this is moisture-proof, at least in a dry place, such as the inside of a building. When the rack is reached the lead is stripped from the end of the cable and the wires formed up, boiled out with beeswax and soldered to the clips on the line side of the distributing board, thence by jumper wires to the lightning arresters and heat coils, and from there to the banks of multiple jacks. From these the cable comes back to the intermediate distributing board, where, as already explained, the busy lines are distributed proportionately among the different operators by more jumper wires and again cabled back to the board to the line signals and answering jacks.

The current for signaling the operators is furnished by two sets of accumulators of eight cells each, of 150-hour capacity, only one set of which is in use at one time, while the other is being charged or held in reserve. At the present time one set of batteries will run the board four days.

As shown in the illustration there are also four direct-coupled motor-generator sets, two for charging the batteries, one being connected to a direct current of 500 volts, the other to an alternating current of 104 volts. The other two motor-generators are connected to the current from the same sources of supply, the generating side furnishing alternating current for ringing the subscribers. Only one set of these motor-generators is in use at one time. Should both of these sources of supply fail there is also a pole-changing battery-generator which can be thrown in on the ringing circuit. At eight cents per kilowatt-hour for alternating and six cents for direct current, the bill for power for the first month was only about $4, which included the initial charge of the batteries, and this at a time when lines were being changed and insulation very imperfect. It is expected that the bill will be much lighter from this time on.

In order still further to popularize the service the company proposes to adopt the measured-service system on a sliding scale which will give about four classes of service, as follows:

1. A flat rate unlimited service, such as is now in use.
2. A flat rate based on 600 calls, with five cents for additional calls.
3. A subscriber's meter, in which the subscriber registers his own call when asked to do so by the operator with a minimum rate of $1 per month.
4. "Nickel-in-the-slot" pay station with a guarantee of $1 a month.

It is expected that a system of this kind will greatly increase the company's business, and, under the present progressive order of things, it is not hard to predict a brilliant future for the new exchange.

A New Firm of Advertising Advisers.

STEPHEN L. COLES.

Mr. Stephen L. Coles, who recently resigned as managing editor of the ELECTRICAL REVIEW, has associated himself with Mr. M. J. Shaughnessy, of New York city, in the business of preparing and publishing technical and trade literature and advertising for manufacturers and others who wish really helpful assistance in such matters. The relation between these gentlemen and their patrons is very similar to that between lawyer and client. Mr. Shaughnessy is well known among general advertisers. He organized the advertising department for John Wanamaker when the latter began business in New York city. He also prepared and placed advertising for the first electrical show, at the Grand Central Palace, New York, in 1896, which will be recalled as a great success. Mr. Coles has many warm friends and acquaintances in the electrical and allied industries. Through his long experience in technical journalism and other newspaper work he is thoroughly posted as to the needs of manufacturers and others seeking the widest and best publicity for their product. Messrs. Shaughnessy and Coles are established in Temple Court, 5 Beekman street, New York city, where the friends of both will be welcome.

M. J. SHAUGHNESSY.

Standardizing Street Railway Equipment.

The Committee on Standardizing of Street Railway Equipment, appointed at the recent meeting of the executive committee of the American Street Railway Association, has begun active work with a view of presenting a comprehensive report on the subject at the annual meeting of the association in October next. T. E. Crossman has been appointed secretary to the committee, and he, in conjunction with the members of the committee, will visit some of the leading manufacturers of street railway equipment to ascertain their views on the subject of standards.

The members of the committee are John R. Graham, Lynn & Boston Railroad Company, Boston; N. H. Heft, Meriden Electric Railroad Company, Meriden, Ct.; Frank G. Jones, Memphis Street Railway Company, Memphis; Willard J. Hield, Twin City Rapid Transit Company, Minneapolis; Conway F. Holmes, Metropolitan Street Railway Company, Kansas City. They request that all who are interested in the subject will correspond with the secretary of the committee, whose address is 1829 Park Row Building, New York, prior to May 20, at which time a meeting of the committee will be held in Buffalo.

Adjustable Contact Knife Switches.

The essential requisite of a knife switch is that when it is closed it must form a perfect circuit for the passage of the current. In other words, there must be perfect contact between the knife blade and the clips into which it works, and to secure this it is evident that both blade and clips must be perfectly flat and that the latter should be held against the blade with a uniform pressure at all points. In many types of knife switches this is not the case, the bearing between the blade and the clips being along one edge, with the result that the contact surface between the two is much diminished, leading to heating and other troubles. In order to remedy this defect it has been a common practice to make the contact pieces exceedingly heavy and to force them against the knife under heavy spring pressure. This practice in large switches, carrying large currents, often makes the switch stick so tightly as to require two men to open a circuit and results in destructive wear at the contact points.

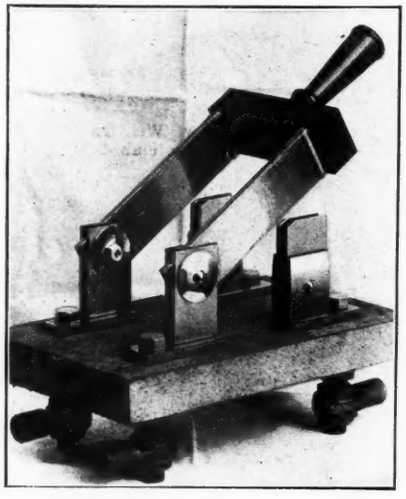


FIG. 1.—ADJUSTABLE CONTACT KNIFE SWITCH.

In the switch here illustrated, which is made by the Barkelew Electric Manufacturing Company, of Middletown, Ohio, the clips are normally straight and parallel and bear against the sides of the blade by an independent curved spring strip on each side, excellently shown in the end view (Fig. 2). These curved spring pieces are connected by a screw passing through the clips below the blade and threaded into one of the springs. By adjusting this screw any desired pressure may be obtained or wear may be taken up. The switches are made in sizes of from 75 to 3,000 amperes.

FIG. 2.—END VIEW OF SWITCH.

Telephone Consolidation in the Southwest.

Details for the consolidation of a number of important independent telephone companies throughout the Southwest were completed recently by the syndicate which is headed by Mr. George R. Webb, and at the meeting of the directors of the United Telephone and Telegraph Company, held in Baltimore, Md., on that date the following properties were acquired: Maryland Telephone and Telegraph Company, capital stock, $1,000,000; Pittsburgh & Allegheny Telephone Company, $1,500,000; West Pennsylvania Long-Distance Telephone Company, $1,000,000; Home Telephone and Electric Company, $200,000; Allegheny County Telephone Company, $200,000; Harsford County Telephone Company, $10,000. About 50,000 telephones, all in actual operation or under contract awaiting installation, will be added to the combination, and will then be connected with the United States (long-distance) Telephone Company.

The United Telephone and Telegraph Company, which has absorbed the interests mentioned above, was chartered with a capitalization of $7,500,000 under New Jersey laws, and the financial plans of the corporation provide for the issuance at once of $1,500,000 in common stock, and $2,000,000 in preferred. An underwriting syndicate has been formed, it is announced, to take up the preferred stock at 85 per cent of its par value. The directors of the company are Alexander Brown, Henry A. Parr, T. J. Heyward, S. Davies Warfield and James Bond, of Baltimore, and John Hedden, third, of New Jersey. In line with his plan for withdrawing from active connection with any corporation before going abroad, Mr. Brown will retire from the board of directors, his successor being Mr. George R. Webb. It is understood that Mr. Webb will be the president of the company. Additional directors are to be placed on the board representing the Pittsburgh interests, and it is considered likely that James D. Callery, M. K. McMullin and J. H. Reed will be appointed.

Industrial Notes

THE AMERICAN TOLL TELEPHONE COMPANY, Cleveland Ohio, makes an extensive line of slot machines for toll lines. They are made for local and long-distance service.

WHEN IN THE MARKET for alternating-current wattmeters you should write to the Electric Appliance Company, Chicago, and become informed, regarding the Guttmann, at least, that is the way that company puts it.

THE CHICAGO GENERAL FIXTURE COMPANY, Adams street, Chicago, has always in stock a complete line of electric lighting fixtures of all patterns. This company makes a specialty of fixtures for churches, theatres, public buildings, and the ornamental hangings for residences and offices.

THE VALENTINE CLARK COMPANY, with offices at 234 La Salle street, Chicago, has three yards, located at Pinconning, Mich., Green Bay, Wis., and New London, Wis. Cedar poles are kept in the above named places and are delivered from there for street railway and lighting work.

FRED. M. LOCKE, Victor, N. Y., manufacturer of insulators, has recently received from the professor of Electrical Engineering, Worcester Polytechnic Institute, Worcester, Mass., some interesting data of tests of the efficacy of the Victor type of insulators made in that laboratory.

THE JEANESVILLE IRON WORKS COMPANY, Jeanesville, Luzerne County, Pa., is mailing its advance sheet No. 9, giving working data on steam pumps. The manner of listing pumps which is followed in this folder is believed by the company to be new, and is said to be very handy in selecting a size for any given work.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, 831 Arch street, Philadelphia, has recently mailed its calendar blotter for the current month, and is sending out with it two folders on the Roberts fixture-block and standard Bryant-Edison sockets. Full descriptive matter and catalogues will be mailed on request.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has issued bulletin No. 64 dealing with typical installations of chloride accumulators. The pamphlet contains eight pages, seven of which are handsomely illustrated with pictures of different installations by the company for various manufacturing concerns.

THE CHRISTIENSEN ENGINEERING COMPANY, Milwaukee, Wis., since moving into its new plant has greatly increased facilities for the manufacture of the Christensen air brake for street railway use. A special department will be devoted to the manufacture of dynamos and motors. A handsome catalogue is now in preparation and will soon be ready for distribution.

CHARLES P. TURNER, M. E., who has been connected with the International Correspondence Schools, Scranton, Pa., since 1895, has resigned to accept a position with the Garrett-Cromwell Engineering Company, Cleveland, Ohio. Professor Turner's successor as principal of the school of mechanical engineering is Professor A. B. Clemens.

THE WARREN ELECTRIC MANUFACTURING COMPANY, Sandusky, Ohio, has recently sent out its bulletin No. 15 on Warren transformers. This bulletin is a four-page pamphlet, handsomely illustrated, and containing descriptive matter on the company's transformers, with tables on both the type "T" 133-cycle and type "S" 60-cycle machines. It will be mailed upon application to the company.

PASS & SEYMOUR—JOHN W. BROOKS, SALES AGENT—announce that they have moved their offices and stockroom to No. 130 West Jackson Boulevard, Chicago, Ill., in order to make more room to take care of the rapidly increasing demand for the P. & S. specialties. Mr. Brooks will give all orders his personal attention and requests the continuance of the favors of his old friends.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is mailing its Bulletin No. 4247, the subject treated being sewing machine motors and their attachments, all of the celebrated "G. E." types. The motors described in the pamphlet are wound for 115 volts, direct, or 52 or 104 volts alternating current, at 60 cycles. The bulletin and other descriptive matter may be had from the company, post free, on application.

THE EUREKA ELECTRIC COMPANY, of Chicago, Ill., claims to be the only telephone manufacturing company operating its entire plant under its own roof. The company manufactures all of its parts from raw material and has one of the most perfect lighting plants of its own in its own building, allowing it to work overtime whenever necessary without taking power or light from any outside source.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, 153-159 South Jefferson street, Chicago, claims several advantages for its "New Western Express No. 3" bridging telephone, claiming that on fairly constructed lines it will ring from 25 to 30 telephones. A recently issued pamphlet describes this and other 'phones, contains prices, etc. This company is building a new factory, located at Winthrop Harbor, Ill.

THE GENERAL MANAGER of the Onondaga Dynamo Company and the Syracuse Electrical Instrument Company, Syracuse, N. Y., manufacturers respectively of dynamos, motors and electrical measuring instruments, says the production and sales of these companies will be nearly tripled for the Spring months of this year. These companies now occupy an entire building recently equipped throughout with modern machinery.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, Pa., is mailing its new catalogue No. XI. The book is a very artistically prepared pamphlet and contains careful descriptions with copious illustrations of the company's well-known electrical measuring and other instruments. Much care and money have been spent upon the book by the company, which believes it to be the most complete and reliable catalogue ever issued by any instrument maker in the field.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, has recently moved its New York office from the Washington Life Building into the Parker Building, Nineteenth street and Fourth avenue. Owing to the largely increased sales of the New York office it was found necessary to have more room for stock and offices. The new offices are much larger in every way and the company will be able to carry a much more extensive stock of incandescent lamps than heretofore.

THE CENTRAL ELECTRIC COMPANY, Chicago, has just issued a folder on National telephone cables. The company claims that the cable insulation is purer, heavier and one-eighth inch wider than that used in other cables and that this causes the cable to be larger in diameter, making necessary more lead in the casing. Therefore the cable is not so apt to break when bent and is heavier per foot than other cables. It is stated that a single thickness of paper used in these National cables offers a resistance of 500 megohms per mile.

SIPE & SIGLER, Cleveland, Ohio, manufacturers of the Willard storage battery, have received another contract from the Cleveland & Chagrin Falls Electric Railroad Company for a battery to be installed on the railroad company's division 14 miles east of Chagrin Falls. This battery will consist of 265 cells of the Willard type, of 400-ampere-hour capacity, and will be supplied with current by an extra feeder. A motor-driven booster will be installed at the power-house for raising the voltage of the current supplied through this feeder.

JAMES S. BARRON & COMPANY, of 24 to 30 Hudson street, New York city, reports that it is receiving a large number of inquiries and orders for its recently improved bridle rings. The bridle ring is made of the best quality of iron and heavily coated with tough glass enamel. The ring is easily screwed in place without tools in the most difficult positions. The company is also manufacturing a shield for inserting the bridle ring when it is to be used in brick, stone, or ironwork, the bridle rings screwing directly into the shields, which hold the rings rigidly in position.

THE AMERICAN ELECTRICAL HEATER COMPANY, 195 River street, Detroit, Mich., has recently mailed a catalogue of its products which presents a very pleasing appearance and contains descriptive matter of everything that the company manufactures, from rheostats to soldering irons, all of which are heated by electricity. The company states that it is enjoying at the present time the largest trade it has had since it began business some time ago, and has recently equipped some of the largest concerns in France with its soldering irons. The catalogue will be mailed to any one interested upon application to the company.

GEORGE W. LORD, 2238 to 2250 North Ninth street, Philadelphia, Pa., is mailing pocket maps of the United States, Porto Rico and the Philippine Islands. These maps are of peculiar interest at this time and are used by Mr. Lord as a means of advertising the well-known Lord boiler compounds. The factories in which these compounds are made are said to be the largest in the world devoted exclusively to the manufacture of water-purifying chemicals. To any steam user interested copies of these maps will be sent on application, together with a valuable book on water contamination.

THE HAINES & NOYES COMPANY, manufacturer of guaranteed telephone apparatus for every possible use, announces that it has now consolidated its sales department and factory at 118 to 132 West Jackson Boulevard, Chicago, and that it is prepared to fill all orders, large and small, very promptly. The increased space will permit the company to manufacture telephone apparatus in large quantities, and it states that it will have a large stock on hand at all times. The company states that it is adding many improvements to its instruments, and will be glad to send latest bulletins to parties requesting them.

THE EUREKA ELECTRIC COMPANY'S new toll pay station apparatus is said to be meeting with pronounced success; its new three-coin box, with 5-cent, 10-cent and 25-cent slots, is quite popular. These boxes are sold separately or complete on telephones. The company claims this pay station apparatus can not be worked as can most other boxes. Prices and full information the company will be pleased to furnish upon application to the main office, 157 to 167 South Canal street, Chicago, Ill. The company also manufactures a single coin box as well as a box to take two coins, either 5-cent and 10-cent, or 5-cent and any other coin.

THE GARTON-DANIELS COMPANY, Keokuk, Iowa, manufacturer of the well-known "G-D" lightning arresters, states that its sales are showing a remarkably steady and pleasing increase. Garton arresters are claimed to have the smallest air-gap and the lowest resistance discharge path, thus affording the lightning an easier and quicker exit than others of higher resistance. Their action is said to be positive and lines on which they are installed are not likely to be grounded by them. Pam-

phlet 28A, which may be had for the asking, describes this useful apparatus in all its styles and sizes. If other or more detailed information is desired a line to the company will bring full particulars.

THE GARVIN MACHINE COMPANY, Spring and Varick streets, New York city, announces in a circular that it has in stock some second-hand machinery, and it also has in stock some new lathes, shapers, and drill presses. The company is placing on the market a small hand surface grinding machine, which has transverse as well as large longitudinal feeds. This machine is intended for all the necessary requirements of a tool of that kind. The slide is balanced by a weight in the column making it very easy of adjustment, and the table is adjusted by a small hand wheel, by which a close adjustment may be obtained through one inch. The sliding table is finished with a T-slot, which enables the work to be easily attached to it. The machine is specially adapted for finishing flat pieces, such as blanking, piercing and stamping dies.

THE AMERICAN CIRCULAR LOOM COMPANY, Chicago, Ill., is mailing a very unique removal announcement stating that its offices at 141 South Clinton street have been leased to the Aaron Electric Company, and that the American company moved to its new address at 128 West Jackson Boulevard, Chicago, on April 22. Thomas G. Grier is the company's western manager, and will continue in charge of the new offices. The announcement card which gives notice of this change is a cream-colored slip some three by five inches in size, bearing the printed announcement at the bottom, while at the top is pasted a pretty and unique figure of an Eighteenth Century gentleman, done in colors.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., is mailing its bulletin No. 3029, replacing bulletin No. 3017, under date of April 1, the subject-matter being alternating and direct-current exhaust fans, direct-connected. With the folder goes a discount sheet for the trade and other circular matter directing attention to Emerson ceiling fans for high-tension alternating systems, the Emerson fan motors, and ceiling fans for low-tension alternating systems, besides which exhaust fans of an entirely new type are noted, and a two-page folder regarding rates for electric service. All of this matter will be sent gratis on application to the company at its offices, either 714 to 718 St. Charles street, St. Louis, or 136 Liberty street, New York.

THE HARDY LAMP COMPANY, Pittsfield, Mass., announces that its sales of incandescent lamps are steadily increasing in a very satisfactory manner, and that the use of its lamps is becoming more and more general every month. The "barrel lot price list"—for lamps of all candle-powers in barrel lots—is said to be the basis of the increased sales and is a very satisfactory means to the consumer of procuring a small number of lamps at an unusually reasonable figure. If the consumer uses 1,000 or more per year, the company advises that he write for contract prices. It also advocates a trial of its double-coil lamps for factory use, stating that increased efficiency and high luminosity make them unusually attractive for the illumination of factory buildings.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., is mailing a return postal card on which it notes the issue of two new bulletins, No. 114 and No. 115. Bulletin No. 114 illustrates and describes the S. K. C. frequency changer, a single machine intended to accomplish exactly what its name implies. In addition to altering the periodicity the machine can be arranged to deliver current of a different phase relation and voltage to that which is supplied to it. Bulletin No. 115 contains a description and diagrams of high-voltage testing sets arranged for all pressures up to 120,000 volts. The company advises that either of these bulletins, or both, are at the disposal of any one interested in the matter, who will take the trouble to write and request them.

THE LAKE SHORE LIMITED EXPRESS, of the Lake Shore & Michigan Southern, New York Central and Boston & Albany railways, has had four new trains added to its service, the cars being Pullman vestibules, each train consisting of a baggage car, buffet, library, smoking, dining car, three drawing-room and stateroom sleepers, and an observation compartment car. One of the unique features of the cars composing the new trains is their names, which were selected entirely from Shakesperian characters, three of them being named Romeo, Claudio, and Orsino. With the addition of these new cars the trains of the Lake Shore are said to be singularly complete, being lighted throughout by electricity and having electric heating devices in the toilet rooms so that ladies can curl their hair without recourse to the old-fashioned alcohol lamp and other similar apparatus.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., has issued its Bulletin No. 014 under the caption of "An introduction to the general line of machinery" manufactured by the company. The book includes data regarding industrial railways, electric locomotives, steam and electric hoisting engines, parabolic boom towers, steam shovels, Hunt elevators, automatic and cable railways, conveyers, overhead trolleys, coal crackers, and stevedore and transmission rope. The company states that it will not sell any machine that is not as good in every respect as though the purchaser himself had bought the material and supervised its construction in the factory. Full particulars and descriptive matter will be mailed upon application to the company, either at its New York office, 45 Broadway, or at the factory, and such requests for catalogues or other information will be promptly attended to.

IN GOVERNMENT WORK the Lundell motors and generators, manufactured by the Sprague Electric Company, are used to a very large extent. Recent orders include 17 motors of various sizes for the Norfolk Navy Yard; three 35-horse-power motors for the Mare Island Navy Yard; four motors for the Boston Navy Yard, to be used on metal working machines, and five motors, one generator and a two-kilowatt ventilating set for the Brooklyn Navy Yard. In addition to the government orders, the Sprague Electric Company reports the following among its large sales: Steelton Light and Power Company, one 125-kilowatt belted-type generator; Columbia University, three 75-kilowatt engine-type generators; C. S. Ashley, one 125-kilowatt generator; Pittsburgh Reduction Company, one 25-horse-power motor and one 166-horse-power motor; National Meter Company, one 37½-kilowatt engine-type generator; Chase Rolling Mill Company, one 125-kilowatt belted-type generator, and the Evansville Gas and Electric Company, one 150-kilowatt generator.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, through its secretary, Mr. James Wilson Bullock, states that it has acquired control of 15 acres of land directly opposite the present plant at East Norwood, Ohio. Upon this tract the Norwood Foundry Company will erect a foundry building 200 feet long by 150 feet in width; a pattern storage house of fireproof construction, 50 by 150 feet, three stories high, and a modern office structure. All these buildings will be built of buff pressed brick with steel frames and trusses to conform to the present buildings of the Bullock company. The foundry will be equipped with three electric cranes, the largest of which will have a capacity of 50 tons. The side bays, which will be 25 feet in width, will be served by hand traveling and jib cranes. The plant will be of the most modern character, and electricity will be used for power and lighting throughout. While this foundry will be operated under the name of the Norwood Foundry Company, it will serve primarily the needs of the Bullock company, and will also be in position to handle outside orders. That it will be operated successfully is guaranteed by the fact that it will be under the direction of Messrs. Hoffinghoff & Lane, of Cincinnati.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, reports that the success in introducing its new G. I. flush push-button switches is extremely gratifying. The mechanism of this switch, which is quite simple, is of a peculiar construction which insures absolute certainty of a quick make and break of the contact parts. After the button has been pushed to a certain distance the making and breaking of the contact are absolutely beyond the control of the operator's hand. This special construction of the moving parts is a further advantage in avoiding the possibility of a switch being left on any dead centre. The company states that the business of its lighting supply department has never been better. Salesmen report that business is opening up all over the country in a most satisfactory manner. A new electric time switch, which is one of the best and most practical of its kind, has been introduced. By the use of this switch the lights in connection with the clock can be set to turn off and on at any time required, and when once set it operates continuously, needing no attention except winding every eight days. The switch is especially adapted for show windows, storerooms and advertising signs. By the use of this switch the cost of lighting will be largely reduced. Every merchant using electricity will certainly be interested when he is shown this valuable feature, as the switch really pays for itself in two or three months. The switch is operated by an eight-day clock with double spring lever and large eight-inch dial, mounted with an attractive nickel-plated case. Catalogues and descriptive matter will be mailed upon application.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, reports a steady increase of business in all departments. A few months ago 10,000 square feet of additional floor space were added to its already large and well-equipped factory, and arrangements have been recently made for the addition of 21,000 more. This will be equipped with the most modern machinery, and will facilitate the handling of orders with even greater promptness than heretofore. The small switchboards of the "Express type" which this company recently put on the market have proven very popular and are in great demand, orders for over fifty having been received since March 15. In order to meet the demand for silk and cotton-covered wire and switchboard cable, the insulating department has been increased to double its former capacity, and is prepared to fill orders for any size or kind of silk or cotton-covered wire on short notice. The company also announces that it owns 90,000 of the finest cedar poles in Michigan, which it is prepared to supply in carload lots to consumers. Among the orders for small switchboards, varying in size from 50 to 300 lines each, recently received by this company are the following: Williamsburg, Pa.; Russell, Iowa; Somerset, Pa.; Chrismaw, Ill.; Webster, S. D.; Grandbury, Tex.; West Chester, Pa.; Bartelsville, I. T.; Bishop Hill, Ill.; Woonsocket, S D.; Tama, Iowa; Royersford, Pa.; Columbus Junction, Iowa; Little Rock, Ark., Marco, Ind.; Shawnee, Ohio; Canadian, Tex.; Troy, Ind.; Savannah, Ill.; Chadwick, Ill.; Black River Falls, Wis.; Astoria, Ill.; Concordia, Kas.; Ashland, Ky.; Blue Rapids, Kas.; Greenleaf, Kas.; Huntingburg, Ind.; Virginia, Ill.; Logan, Kas.; Hurley, S. D.; Sparta, Ill.; Miltonville, Kas.; Scandia, Kas.; Streitsville, Ohio; Lexington, Miss.; Story City, Iowa; Versailles, Mo.; Dalton, Ohio; Doylestown, Pa.; West Grove, Pa.; Westphalia, Ind.; Linton, Ind.; Clifton, Kas.; Sanborn, Ind.; Estelline, S. D.; San Francisco, Cal.; Joy, Ill.; Blue Earth, Minn.; Augusta, Ill.; Sullivan, Ind.; Dawson, Minn.; Wellsboro, Pa.